MAINE DEPARTMENT OF INLAND FISHERIES AND GAME

FISH SURVEY REPORT NO. 2

A BIOLOGICAL SURVEY OF THIRTY-ONE LAKES AND PONDS OF THE UPPER SACO RIVER AND SEBAGO LAKE DRAINAGE SYSTEMS IN MAINE

A REPORT BY

GERALD P. COOPER

Instructor in Zoology, University of Maine

TO

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GEORGE J. STOBIE, *Commissioner*

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ANNOUNCEMENT

This is the second of a proposed series of reports on biological surveys of fresh waters of Maine. These surveys are being conducted by the Maine Department of Inland Fisheries and Game in cooperation with the Zoology Department of the University of Maine. The first report which has just recently been published dealt with "A Biological Survey of the Waters of York County and the Southern Part of Cumberland County, Maine." The present report deals with the results of a survey of most of those lakes and ponds, important to fishing, of the upper Saco River drainage system and the lakes and ponds which drain through Sebago Lake into the Presumpscot River, as well as Sebago Lake itself.

The present survey was made during the summer of 1938. It was originally the plan of the survey to study both the ponds and the streams of this area but the excessive amount of rain in July, 1938 made the streams of this area abnormally high throughout most of the summer. Thus it was very advisable to leave the study of the streams of the area until such time as the amount of water in these streams was back to normal.

The plans for the survey in the future are to continue with a study of the streams of this same area and then to proceed with the Royal River drainage and the lower part of the Androscoggin River system. It is the plan of the State Department of Inland Fisheries and Game to continue this survey in the future until most of the more important fishing waters in the State have been studied. The survey can be carried on much more efficiently if the work is done by unit areas, and a stream watershed is believed to be the best working unit area. We are therefore trying to study most of the important lakes and streams of a given watershed before moving on to another. With this in mind, it is requested that those fishermen who are interested in waters of the State which have not been studied as yet will be patient in waiting until the survey reaches their particular region.

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By Gerald P. Cooper

Instructor in Zoology, University of Maine

INTRODUCTION

A biological survey of lakes and ponds of the upper Saco River and Sebago Lake drainage systems of Maine was conducted during the summer of 1938 by the Maine Department of Inland Fisheries and Game in co-operation with the Zoology Department of the University of Maine. The ponds which were surveyed make up a considerable proportion of the great concentration of ponds which exists in the extreme southwestern part of the State. Most of the ponds of the Sebago Lake drainage are located in the northern part of Cumberland County, and most of the ponds of the upper part of the Saco River drainage are located in the southern part of Oxford County. These drainage systems and the locations of the lakes and ponds of this region are indicated on a large map accompanying this report (see inside of back cover).

The results of the survey have a very practical application. The Maine State Fish and Game Department has developed its trout and salmon propagating establishments to the extent that fish culture in Maine is big business. The task of distributing the millions of fish that are raised annually in the Maine hatcheries to lakes and streams where they will give the best returns to the sportsmen is one which involves a great deal of responsibility. Furthermore, the stocking of fishes in these ponds can not be done effectively without a knowledge of how well each pond is able to support the fishes which are stocked. The present biological survey of these ponds has been conducted largely with the purpose of getting as much information as possible concerning each lake and pond and its suitability to support trout and salmon. The survey has been sufficiently intensive so that it not only indicates whether or not a pond can support trout or salmon at all, but the numbers of these fishes which should be stocked each year can be calculated with a fair degree of accuracy. It is also within the scope of the purpose of the present survey to be able to make other recommendations on proper management of lakes and streams, namely, on the stocking of species other than trouts and salmons, the control of warm-water species in trout and salmon ponds, the planting of food organisms, and the desirability of changes in present fisheries legislation pertaining to such items as open seasons and legal size limits. Also included in the aims of the survey is the continuation of studies on the distribution of fresh-water fishes in the State and on other important phases of fisheries biology such as studies on fish life histories and parasites of fishes.

The survey has been financed almost entirely by the State Fish and Game Department, while some equipment has been furnished by the Zoology Department of the University of Maine. The personnel of the survey included Russell T. Norris, H. R. Newcomb, and the writer. Valuable assistance in collecting samples of fishes from the various lakes and ponds was obtained through a W. P. A. Project (W.P. 2465, O.P. 665-11-3-16), through which we had the assistance of four men for a period of three weeks.

The field survey party spent the entire period from June 10 to September 15 collecting survey data[1]. The survey party had portable equipment including tents, boat, and car, which made it possible to move from one lake or pond to another with little loss of time. All lakes were sounded, and maps giving these soundings are presented in this report. Water analyses were made on temperature, oxygen content, and pH content ("acidity") of the water at various depth levels in each lake. Samples of plankton and bottom food organisms were collected to determine basic fertility. Fish collections were made by gill nets and seines to determine the present status of fish populations. Fish collections were preserved and scale samples and stomachs of all the game fishes were saved for future life history studies. The analyses of fish stomach contents, plankton samples, and bottom samples were made in the laboratory subsequent to the field survey. Also, in the laboratory, the final maps showing the soundings were prepared, and the temperature and oxygen data were analyzed in conjunction with the sounding data to give the amount of trout water in each lake.

Even in a relatively small section of the State such as that which was surveyed during the summer of 1938, there is great confusion concerning the names of ponds, lakes and streams. Many different ponds have the same name and many ponds have more than one name, and some ponds have no name indicated at all on available maps. Because of this confusion in the naming system for ponds, a numbering system has been used in order to avoid any possible error in identification. This numbering

[1]A brief resume of field methods is given at this time; a more complete account of field and laboratory methods is given in Appendix B of this report.

system, applied to both lakes and streams, has been described in detail in Survey Report No. 1 dealing with the waters of York County and the southern part of Cumberland County. It is sufficient at present to point out that by this system no two ponds have the same number, so that the numbering system can be used to identify positively any pond even though some may have the same name. Throughout this report not only the name and number of each pond, but also the county and township in which it is located, are given, so that there is practically no possibility of mistaking the exact identity of each. The large map, accompanying this report (see inside of back cover) indicates the name, number and location of each of the lakes and ponds which were studied.

The results of the survey are presented in this report according to the following plan: The 31 ponds which were studied are considered as a unit and the results of each phase of the survey are given separately for the group of ponds as a whole. All of the data on water analyses and soundings for all of the ponds are given and discussed first. This is followed by a description of the kinds and abundance of plankton, bottom food organisms, and fish populations, each of which are taken up as a unit. This is followed by the formulation of a stocking policy to apply to the group of ponds as a whole, as based on the survey findings on water analyses, soundings, food organisms and fish populations, and by stocking recommendations for each pond. Other management recommendations are then considered. Finally a brief summary of survey results and stocking recommendations is given separately for each lake and pond.

GENERAL CHARACTERISTICS OF LAKES

Physical and chemical characteristics: Temperate lakes undergo seasonal changes in their physical, chemical, and, to some extent, biological conditions. These changes are of utmost importance to fish life. A discussion of these changes is given at this time[2] in order to aid the reader in evaluating the water analysis data which are given in a later part of this report. Seasonal changes in temperature are the most striking of all the changes in physical conditions in lakes, and these changes in temperature are very important to all of those fishes (including trouts and salmon)

[2]A similar discussion of the seasonal changes in the physical and chemical conditions in lakes was given in Survey Report No. 1, "A Biological Survey of the Waters of York County and the Southern Part of Cumberland County, Maine"; the discussion is given here for the sake of completeness, since a knowledge of these seasonal changes is of fundamental importance to an understanding of the following presentation of the survey data. For a much more complete discussion of the physical and chemical characteristics of lakes see Welch, Paul S.: 1935. Limnology. McGraw Hill Book Co., New York, 471 p.

which need cold water. Most seasonal changes in chemical conditions are dependent upon the water temperature cycle. The water temperature cycle is largely dependent upon two facts: (1) the maximum density of water occurs at a temperature of 4° C. (39° F.), that is, a unit volume of water is heavier at 4° C. than at either a colder or warmer temperature; and (2) water in lakes is heated mostly by contact with the air at the surface.

Each year practically all lakes in Maine pass through four distinct stages with respect to water temperature. In a large (over 1,000 acres) and deep (100 feet or more) lake, the distribution of temperature during these four stages is approximately as follows:

1. *Mid-winter stagnation stage:* Lasting from December until the ice "goes out" in early spring. Water temperature 32° F. just below the ice and becoming gradually warmer toward the bottom; seldom warmer than 39° F. on the bottom and usually not over 36 to 38° F. During this period there is practically no movement of the water.
2. *Spring turnover stage:* Begins usually only a few days after the ice disappears in the spring, and lasts only a few days depending upon the amount of wind and the air temperature. Water temperature uniform from top to bottom and at or near 39° F. Wind action produces water currents which roll and mix the water completely from top to bottom.
3. *Summer stagnation stage:* Commences immediately after the spring turnover stage and continues as long as warm weather lasts, usually into September. During this period the lake water may be divided into three distinct depth regions on the basis of temperature: (a) An upper layer (epilimnion) in which the water is quite uniformly warm (in large lakes this layer extends down about 18 to 25 feet; the temperature at 20 feet would be perhaps 2 or 3 degrees colder than at the surface), (b) a middle layer (mesolimnion or thermocline), extending from a depth of about 20 feet to 30 or 35 feet, through which there is a very sharp drop in temperature with increase in depth (for example: the temperature might be 76° F. at 20 feet and 50° F. at 35 feet), and (c) a lower layer (hypolimnion), extending from 30 or 35 feet to the bottom, through which the drop in temperature is very slight compared to depth (for example: 50° F. at 35 feet, and 44° F. at 100 feet). During this summer stagnation period, the warmer water is on top because it is the lighter, and this difference in weight between the upper warm and deep cold water is very great. Summer wave action and water currents tend to force the warm water down to mix with the cold water below, while the greater weight of the cold water tends to work against this mixing; the warm water extends

down farther and farther as the summer progresses and the depth to which it does finally descend depends upon the strength of the waves and water currents which in turn depend upon the size and shape of the lake and the amount of wind action.

4. *Fall turnover stage:* Commences after the lake water has cooled down to 40° to 45° F. in the fall and lasts for several days to a week or more (in October or November) depending upon general weather conditions of air temperature and wind. Water temperature uniform from top to bottom until the water cools to 39° F. or slightly less. Water "rolls" and mixes from top to bottom due to wind action.

The change from one to another, of these above stages in lakes, is mostly quite gradual due to the high specific heat of water. After the ice disappears in the spring, the 0° F. water at the surface in contact with warmer air begins to heat up. As it does so, it becomes heavier and sinks to mix with and displace the colder water below. This process continues until all the water in the lake is at 39° F. and at its maximum density. Since there is then no difference in weight between different layers of the water, a moderate wind can roll the water from top to bottom. As the surface water now comes in contact with the warmer air, its temperature rises above 39° F. and its weight per unit volume decreases. This warm water now stays on top, and continues to do so as the lake warms up during the summer. We then have the summer stagnation stage as described under "3" above. When the water begins to cool in the fall the process is reversed. The water cooling at the surface becomes heavier and sinks to displace the warmer water just below. This continues until all the water is of a uniform temperature from top to bottom. The water will then remain uniform in temperature from top to bottom until it cools to 39° F. Thereafter, as the surface water cools below 39° F., it becomes lighter than the warmer water just below and therefore stays on top; this process continues until ice forms on the lake and conditions are as described under "4" above.

The yearly cycle of dissolved oxygen, pH ("acidity"), and free carbon dioxide content of lake water depends upon the temperature cycle, and also upon other factors, namely:

1. The inherent ability of cold water to contain more dissolved oxygen than warm water
2. The production of oxygen in water by aquatic plants, in Maine lakes mostly the plant plankton since the higher plants are generally rare
3. The absorption of oxygen from the air by water at the surface

4. The liberation of carbon dioxide into the air by water at the surface
5. The amount and rate of decomposition of organic mud on the bottom and suspended in the deep water—this decomposition at the bottom removes oxygen and produces carbon dioxide
6. The removal of oxygen from water by both animal and plant life, including bacteria
7. The liberation of carbon dioxide into water by both animals and plants

Of the above factors, Nos. 1, 3, 4 and 5 are probably the most important in the changes of the chemical properties of lake water (at least in most Maine lakes).

When water comes in close contact with the air it rapidly becomes saturated with oxygen and rapidly loses most of its carbon dioxide. Thus, when lake water is being mixed from top to bottom during the spring and fall turnover stages the oxygen content of the water from the surface to the bottom is high and the carbon dioxide content is low. Following the spring turnover, however, temperature stratification makes it impossible for the deeper water to come in contact with the surface. Whether or not this deeper water will retain enough oxygen for trout and salmon throughout the summer, and not accumulate too much carbon dioxide, depend mostly upon the amount of water in the hypolimnion and the rate of decomposition of the bottom material. In a deep lake a moderate amount of decomposition might not be very serious because of the presence of a large amount of deep cold water; in a more shallow lake, the same amount of bottom decomposition might be sufficient to make all of the deep water unsuitable for fishes.

Under natural conditions in lakes, the oxygen content and carbon dioxide content tend to be complementary in their vertical distribution since those processes which take up oxygen liberate a somewhat corresponding amount of carbon dioxide. Thus, where the oxygen content is high, the carbon dioxide is usually low; and vice versa.

Tests made during the past two years on about forty Maine lakes indicate that most of the natural lakes in southern Maine are more or less acid, even the upper water in the epilimnion. Summer tests on all of these lakes indicated that the deep water during summer is much more "acid" (a higher hydrogen ion concentration) than the upper water. This variation in vertical distribution of pH reflects the variation in vertical distribution of carbon dioxide; that is, the deeper water is more acid due to the presence of more carbon dioxide produced by decomposition of bottom material and of organic material suspended in the hypolimnion. Thus, comparative pH tests are regarded, for most lakes of southern Maine, as a fairly good general index of the amount of carbon dioxide in the deeper water.

The depth to which warm surface water will be driven in lakes by the end of the summer depends mostly upon the size and shape of the lake and the amount of wind and wave action. Thus the warm water will be driven down to about the same depth in all large lakes whether they are shallow or deep. This makes the factor of depth in large lakes very important in determining whether or not that lake will have cold water for trout or salmon during the hot part of the summer. Warm water is driven down to a greater depth in large lakes than in small ones, and this makes the size of the lake and the amount of protection which it has against the wind of considerable importance in determining the amount of trout water. In brief it might be stated that the ratio of size to depth is the most important factor in determining how deep the warm water will be driven during the summer time and therefore how far down the trout and salmon will have to go to find a suitable temperature. Some information on this relationship between size and depth of lake or pond and depth to which the warm water (mostly the lower limit of the epilimnion) does descend is available from the present survey. Judging from analyses made during June, July and August (see Table II) on these lakes and ponds of southern Maine, it was estimated that during late summer the warm water (above 70° F.) extended to a depth of:

17 feet in ponds of 56 to 100 acres in area (average for 5 ponds)

18.7 feet in ponds of 101 to 500 acres in area (average for 15 ponds)

23.3 feet in ponds of 501 to 1,000 acres in area (average for 3 ponds)

25.3 feet in ponds of 1,001 to 2,000 acres in area (average for 4 ponds)

25 feet in one lake of 4,867 acres

30 feet in one lake of 28,771 acres

These figures indicate for lakes of various sizes the approximate extent of the upper water which is too warm for trout or salmon during late summer.

The type of pond and consequently the amount of decomposition of bottom mud and organic material suspended in the deep water are the most important factors determining whether or not the deep cold water will keep enough of its oxygen during the summer to support fish life. The ratio of size of the lake to its depth is important to the oxygen content only indirectly in that it determines the amount of the deep water; if the amount of deep cold water is large, then a large amount of decomposition of the bottom mud might still not be sufficient to remove all of the oxygen and there might still remain some suitable trout and salmon water. One fact of particular interest at this point is that temperature, oxygen content, and pH content in water in lakes (except during spells of very windy weather) are quite uniformly stratified, that is, temperature, oxygen and pH are each usually about the same at the same depth over the whole lake.

Stability of lakes and ponds: The physical, chemical and, to some extent, biological conditions in lakes and ponds change from year to year only in proportion to the rate at which bottom material accumulates in the basin of the lake. From the geologists point of view, all lakes are in the process of rapid extinction by filling in of the lake basin with eroded soil and organic materials from aquatic plants and animals. In deep and relatively unproductive lakes with little plant life this process of filling in is, by ordinary standards of time, extremely slow; but in the final stages in very shallow lakes, the process is much more rapid. Fortunately most of Maine's good trout and salmon lakes are of the former type, and are changing very little from year to year. Probably such a body of water as Sebago Lake has not changed appreciably in its physical and chemical properties for the past several hundred years or much longer. Probably, also, such a body of water will not change much for centuries to come, assuming that no large amount of organic pollution will enter the lake. Therefore, the temperature, oxygen and pH data obtained during the present survey should be applicable to these lakes and ponds for many years in the future, and the lakes which are now good trout waters from the standpoint of temperature and oxygen will probably continue to be so for centuries. The fish populations in lakes, however, are subject to a much more rapid change, especially where new species are introduced. A continual knowledge of these changes in each lake is necessary to efficient fisheries management.

Classification of lakes: European limnologists have classified lakes[3] according to their physical, chemical and biological characteristics into three types: *oligotrophic, eutrophic* and *dystrophic.* Some of the important characteristics of these three types of lakes are as follows:

Oligotrophic lakes

Relatively large amount of deep, cold water
Water blue to green and very transparent
Little or no organic material on the bottom in deep water
Oxygen content high at all depths and at all seasons
Aquatic plants rare
Basic fertility: low in plankton, fairly rich in bottom food organisms
Excellent for trouts and salmons and other "cold-water" fishes

Eutrophic lakes

Lake shallow with relatively small amount of deep cold water
Water green to yellow and brownish green and not very transparent
Large quantity of organic material on the bottom and suspended in the water
Little or no oxygen in deep water during the summer

[3]See Welch: 1935. Limnology, pp. 310-315.

Aquatic plants abundant

Basic fertility: very rich in both plankton and bottom food organisms

Usually not good trout or salmon water

Dystrophic lakes

Deep to shallow; in bog surroundings or in old (geologically speaking) mountains

Water yellow to brown and with low transparency

Large quantity of organic mud on bottom

Little or no oxygen in deep water during the summer

Aquatic plants rare

Basic fertility: low in both plankton and bottom food organisms

Occasionally trout (probably never salmon) in deep *dystrophic* lakes; never trout or salmon in shallow or advanced *dystrophic* lakes

The lakes which were examined during the present survey appear to possess a combination of characteristics which, in a general way, resembled at least two of the above types; in other words, it appears that some sort of a similar classification (either two-point or three-point) might be applicable to the majority of Maine lakes. Sebago Lake, for example, resembles the *oligotrophic* type in having (a) more water in the hypolimnion than in the epilimnion, (b) water very transparent, (c) practically no organic material on the bottom in deep water, (d) high oxygen content at all depths during late summer, (e) practically no aquatic plants, and (f) cold-water fishes abundant. It appears, however, that Sebago Lake differs from the *oligotrophic* type in having bottom organisms very rare. On the other hand, many of the smaller ponds in southern Maine resemble the *dystrophic* type in that they have (a) dark brown water, (b) a large quantity of organic mud on the bottom, (c) little or no oxygen in the deep water during summer, (d) aquatic plants rare, (e) scant plankton and bottom faunas, and (f) low calcium content, i.e., they are soft-water ponds. Few if any of these ponds of southern Maine seem to fit the *eutrophic* type, in that they are low in calcium, and have a scarcity of aquatic plants and bottom organisms; however, lakes more similar to this type might be found in other parts of the State. Our study of these Maine lakes and ponds was too incomplete to allow any attempt at critical classification. The study was complete enough, however, to indicate that southern Maine lakes, in their extremes, are of two distinct types with regards to their suitability for cold-water fishes: (a) good trout and salmon lakes resembling the oligotrophic type, and (b) lakes which are very poor or, at best, fair trout lakes (probably not good for salmon at all) and which resemble the dystrophic more than the eutrophic type.

REQUIREMENTS OF TROUT AND SALMON AND OTHER GAME FISHES

The development of a scientific stocking policy must of necessity consider the requirements of the food and game species concerned. These basic requirements of individual species naturally vary somewhat in different parts of the country, as, for example, the requirements of the Brook Trout in Maine waters are probably somewhat different from those of Brook Trout in states farther south and west. The requirements of our game species are not completely known by any means; however, many of the basic requirements are understood in a general way and these may be summarized (based largely on the literature; to some extent on survey results) for some of the more important fish species in southern Maine as follows:

Land-locked Salmon or Lake Salmon, Brook Trout, Brown Trout and Rainbow Trout (These species are here considered as a unit since most of their requirements are very similar.) The requirements of trout and salmon are much the same in lakes and ponds as in streams. The most important of these requirements are:

1. *Cold water:* at least below 75° Fahrenheit, preferably below 70° F. There is considerable evidence that Brook Trout, at least, will live and do well in water 75° F. and warmer in shallow ponds where competing warm-water game fishes, such as the perches, bass and pickerel, are not present; recent studies on Quimby Pond near Rangeley, and reports by Game Wardens from the northern part of Maine substantiate this statement. It appears that in most of the lakes of southern Maine, trout and salmon occupy the deep and cold water partly because of preference but also partly because they can not tolerate the competition of the warm-water species which live mostly in the upper water. The maximum temperature limit of 70° F. is, therefore, tentatively set for those lakes of the southern part of Maine where warm-water game fishes are present.

2. *Oxygen:* at least 5 p.p.m. (parts per million) of dissolved oxygen in the water. The minimum oxygen requirement is set by some investigators at 4 p.p.m.; however our studies on Maine lakes indicate that trout and salmon do best in water with much more than 5 p.p.m. of oxygen. In determining the amount of trout or salmon water in a lake during late summer, it would make little difference whether the minimum was set at 5 p.p.m. or 4 p.p.m., because, in those regions where oxygen is as low as 5 p.p.m., the oxygen content usually varies markedly with slight change in depth.

3. *pH (acid intensity):* of approximately 5.0 to 9.0 for trout, best

above 6 for salmon. Trouts can tolerate much more acid water than many other game fishes. However, a low pH in deep water reflects low oxygen and high carbon dioxide which trout and salmon can not tolerate.

4. *Adequate food supply:* Trout and salmon up to a length of about eight inches feed mostly on insects. These must be mostly bottom insects when trout and salmon are confined to the deep water during the summer months. Thus, the amount of bottom area available to these fish, and the abundance of bottom food organisms are important. Larger trout and salmon feed mostly upon small fishes and, in Maine lakes, the Smelt is the only small fish which is abundant in deep water during the summer. Thus the Smelt is an absolute necessity to the production of large Land-locked Salmon[4] and is probably also important to large Brook Trout and Togue (Lake Trout).

5. *Spawning grounds:* Brook Trout and salmon are inherently stream spawners. (Possibly they do spawn in lakes under certain conditions, but this occurs rarely and is of little general importance.) Therefore, if stocking of a lake is done with the idea of establishing a partially or entirely self-sustaining population of trout or salmon, the lake should have tributary streams which offer suitable spawning conditions for the adults and conditions favorable for good growth of the young for at least two years. However, there are many lakes which lack trout-stream tributaries but which are good enough as trout lakes to justify continued yearly stocking with the realization that fishing will harvest only the stocked fish.

6. *Stream habitats:* Young Brook Trout and salmon (also Browns and Rainbows, not Togue) normally live in streams for two years or more and until they reach a length of at least six to eight inches. It is biologically unsound to plant trout and salmon fry (not Togue) in lakes and ponds. Fry should be planted only in suitable tributary streams. If the lake has no such streams, the fish should be reared in the hatchery to a length of at least six to eight inches before they are planted in a lake.

Togue or Lake Trout Most of the requirements of Togue are similar to those of trouts and salmons but there are some important differences. The Togue is preeminently a deep water species and is seldom if ever found in lakes less than 50 feet deep. They usually live in lakes at a depth of over 60 to 80 feet except during the spawning season or when

[4]Kendall, W. C.: 1935. The fishes of New England. The Salmon family. Part 2.—The Salmons. Memoirs Boston Society Natural History, Vol. 9, No. 1, see p. 146.

the surface water is very cold. At a depth of 60 feet or more in Maine lakes the water temperature is invariably below 60° F. and usually less than 55 or 50° F. at all seasons; thus the Togue lives, and presumably prefers to do so, in colder water than do other trouts and salmons.

The oxygen and pH requirements of Togue are presumably somewhat similar to those of other trouts—at least 5 p.p.m. of oxygen and a pH preferably between 6.0 and 8.0. The deep water in most Maine lakes probably rarely, if ever, becomes alkaline, that is, with a pH above 7.0. The food of the adult Togue is chiefly fish, although they have been accredited with eating a great variety of different types of foods. Togue occur in lakes of southern Maine mostly if not entirely in lakes which have smelts, and smelts are known to be their chief food. The food of the young is not known, although it is presumably mostly insects. Togue are unlike most other trouts and salmons in that they normally spawn in lakes on gravel and in shallow water. Also, presumably, the young go to deep water shortly after they hatch, for extensive seining in shallow water of lakes in the summertime has never (to the writer's knowledge) produced any young Togue.

SMELT Smelt, like the trouts and salmon, live in deep cold water during most of the summer at temperatures mostly less than 60° F. However, there are some authentic records which indicate that smelts do occasionally school at the surface of lakes during the warm summer months. Judging from the distribution of smelts in the lakes covered by the present survey it is believed that their oxygen requirement is similar to that of trouts and salmon, presumably at least 5 p.p.m. The adults of the larger race of smelts feed mostly on small fish; on the other hand, the young smelts and the adults of the small race feed largely on plankton or micro-organisms in the water.

Smelt spawning occurs mostly in streams; however, smelts are known to spawn normally in some lakes, as for instance Lake Champlain on the New York-Vermont line. Possibly also some populations of our smallest race of smelts here in Maine spawn only in lakes. Smelts spawn from late March to early May and the larger race usually spawns earlier than the smaller one. The eggs are adhesive and are stuck on sticks and stones on gravel or rubble bottom.

CHINOOK SALMON This species has been introduced into Maine from the streams on the Pacific coast of North America where it is native. Its temperature and oxygen requirements are presumably similar to those of our native salmon. Adult Chinooks feed mostly on fishes; the young feed on insects. All evidence available thus far indicates that the Chinook Salmon in Maine lakes would compete directly with our native salmon for food. However, the stocking of Chinooks in some Maine lakes appears to have one distinct advantage in that it preys more readily on young warm-water game fishes such as the White Perch and Yellow Perch. The Chinook has thrived well in some Maine lakes where the warm-water game fishes have crowded out the native salmon.

On the west coast the Chinook runs up from the ocean to spawn in streams and, like our native sea salmon, the young stay in streams for a period of 1 or 2 years after which they return to the ocean to make most of their growth. They then come back as 4 or 5 year old fish to the streams to spawn. In all of the species of salmons native to the west coast of the United States, all of the adults die after their first spawning. Other fisheries investigators have expressed the belief that their introduction into the waters of Maine would never result in the permanent establishment of the species. However, there is some indication that the species might become established eventually in some Maine localities. Chinook Salmon have been planted in a considerable number of Maine lakes during the last few years, and many of these planted fish have grown to maturity while confined entirely to fresh water. Cobbosseecontee Lake near Augusta might be cited as an example. During the first part of October, 1937, about 100 adult Chinooks migrated down out of Cobbosseecontee Lake for about ¼ mile into the outlet where they were stopped by a permanent screen. On October 15 the writer observed several adult females digging their nests in a gravel bottom in about four feet of water, and dissection of 8 dead adult female Chinooks found at this same locality indicated that all of them had recently dropped their eggs. A few unspawned eggs in each of the females indicated that they had been able to develop normal-sized eggs while being confined to this fresh-water lake.

WARM-WATER GAME FISHES The four species of warm-water game fishes most important in Maine are the White Perch, Small-mouthed Bass, Common Pickerel and Yellow Perch. These species do not require cold water but rather they apparently require warm water to make their best growth, and the bass, at least, requires relatively warm water in order to spawn. Therefore these species presumably could live in practically all lakes of the state in which they might be introduced. The water in Maine lakes probably never becomes so hot as to be detrimental to any of them; in fact Pickerel probably relish the warmest waters in Maine. On the other hand, there is some evidence that large bass and large White Perch spend at least part of their time in deep cold waters during the hot part of the summer, but the young of these same species live in the warm surface water during the entire summer. The oxygen requirements of these warm-water game species are probably somewhat less than the requirements of trout and salmon, but oxygen deficiency is rarely, if ever, an important factor to these warm-water species since the upper warm water of lakes is practically always saturated with oxygen during the entire period when the lake is free of ice. In other requirements these warm-water game species differ considerably.

White Perch White Perch become abundant in a great variety of different types of lakes, and they seem to become just as abundant in deep and cold trout lakes as they do in warm and shallow lakes. The food of the White Perch consists mostly of bottom insects and small fishes, including the Smelt. They also feed to some extent on plankton crustaceans. Spawning habits of the White Perch are largely unknown to the writer. The spawning season occurs in May and June in some localities, and there are large spawning runs in the major inlet and outlet streams of some lakes. Since perch also occur abundantly in ponds which have no tributary streams at all, it is assumed that they also spawn in lakes to a considerable extent. Reports by several Fish and Game Wardens and by local fishermen indicate that the White Perch drops its eggs on gravel bottom in shallow water.

Small-mouthed Black Bass Bass do best in fairly deep, cold lakes with little vegetation, rocky shorelines and gravel or rubble shoals. Its food is mostly fish, crayfish when available (crayfish are generally rare in Maine), and insects; large bass feed mostly on fish.

Bass spawn on gravel shoals mostly in from 2 to 4 feet of water. The spawning season occurs in the early part of the summer and mostly in June in Maine. It has been found that bass require a water temperature above about 65° F. for spawning. The male guards the nest of eggs and fry, and if the male is caught off the nest and the eggs are left unguarded they are usually destroyed.

Common Pickerel The Pickerel is found in a variety of lakes, both shallow and deep, but the species is best adapted to shallow, weedy lakes with mud bottom. Its food is almost entirely fish after it reaches a length of about 8 to 10 inches, and even small pickerel less than 5 inches long will feed on fish to some extent. The Pickerel eats mostly warm-water minnows and the young of warm-water game fishes in shallow water, but we have evidence of larger pickerel in deep waters feeding on young salmon. Pickerel spawn early in the spring, mostly in May in Maine, in shallow weedy areas of lakes or in similar places in quiet tributary streams.

Yellow Perch The Yellow Perch is best adapted to weedy lakes where the young occur mostly in shallow water, but the adults are to be found in deeper waters particularly in the summer time. Its food is largely bottom insects, small fish, and plankton crustaceans. The Yellow Perch spawns in the early spring, probably during May in Maine. It lays a string of eggs embedded in a jelly-like ribbon which it drapes over vegetation and sticks.

SUITABILITY OF THE WATER IN THE LAKES AND PONDS FOR TROUT AND SALMON

The temperature and oxygen requirements of trouts and salmons were discussed in the preceding section of this report. It is sufficient at this time to state that trout and salmon require cold water with sufficient oxygen. The upper temperature limit of good trout and salmon water is set at 70° Fahrenheit; the minimum oxygen requirement is set at 5 p.p.m. (parts per million). During the summer months cold water is to be found only in the deeper part of a lake. The warm water in lakes is pushed down from the surface; thus, temperature defines the upper limit of trout[5] water. Oxygen deficiency works up from the bottom (presumably with an almost even distribution according to depth) and therefore determines the lower limit of trout water (assuming that, with the oxygen limit set at 5 p.p.m., the presence of carbon dioxide would not be a limiting factor). The amount of trout water which a lake or pond will contain during the summer is the amount which remains between the warm water above and the oxygen-deficient water below. (Conditions during the summer are especially important because trout and salmon normally make most of their growth during this season.) Therefore, the data on depth soundings and water analyses have been analyzed together to determine the relative amounts of trout and non-trout water which exist in each pond during the most critical summer period.

The names and reference numbers of all lakes and ponds which were surveyed, together with their locations, elevations above sea level (as given on the United States Geological Survey Topographic maps) and their areas (as determined by using a planimeter on the same Topographic maps; the areas are probably not very accurate) are given in Table I.

The vertical distributions of temperature, oxygen and pH at one or more stations on each of the lakes and ponds are given (all analyses completely) in Table II. Depth soundings in feet are given on the outline map of each lake (see Figures 1 to 25). The water analysis and sounding data form the basis of evaluation of each body of water according to its "suitability for trout and salmon during late summer" (see diagrams accompanying each lake outline-map).

It has long been recognized by limnologists that conditions in lakes change markedly during the summer; that, as the summer progresses, the warm surface water is driven farther down from the surface, and the oxygen deficiency extends farther up from the bottom. During the present survey, tests were made on three of the lakes at two widely separated dates during the summer, and these tests revealed this change in conditions of

[5]Throughout this report "trout water" means suitable, from the standpoint of temperature and oxygen, for either trout or salmon or other cold-water fishes.

the water to be very marked—see water analysis data on Adams Pond (P. 307) for July 1 and August 14, Wood Pond (P. 313) for June 23 and August 3, and Highland Lake (P. 314) for June 29 and August 20 (Table II). This summer stagnation continues to reduce the amount of available trout water in lakes and ponds until the surface water cools sufficiently to be suitable for trout and salmon, which takes place probably about the middle of September.

The extent to which the suitable trout water in each pond would be reduced by the end of the summer is of utmost importance, for, presumably, a period of a few weeks during which there is no trout water in a pond would make that pond unsuitable for stocking with trout or salmon. Therefore, estimates were made on (a) *how far down the warm water would extend,* and (b) *how far up the oxygen deficiency would extend,* by the end of the summer. In making these estimates the following factors were taken into account:

1. The depth above which temperature was found to be too warm and the depth below which oxygen was found to be deficient at the time of analyses on each pond, and the date on which these analyses were made
2. The known rate of change in Adams Pond, Wood Pond and Highland Lake over a large portion of the summer
3. Size and shape of the pond and its susceptibility to wind and wave action
4. The rate of temperature change through the thermocline
5. The volume and depth of water in the hypolimnion
6. The amount of organic mud on the bottom

In Table III are given, for each pond, the critical temperature and oxygen depths (both those found by analyses and those which were estimated), together with the dates of analyses and the maximum depth of each lake or pond as found by soundings. It is evident from the data given in this table that there is little or no relationship between the depth to which the warm water descends and the maximum depth of the pond. Rather the thickness of the warm-water layer is about the same in ponds of similar size (as previously stated).

The amount of trout water and of non-trout water in each lake or pond was calculated on the basis of these estimated depths for critical temperature and oxygen conditions. Depth soundings were plotted on an outline map of each lake; the critical-temperature and critical-oxygen depth contours, and others, were located; areas within contours were determined; and this information was used to calculate water volumes. The area of lake bottom which would be available to trout was obtained from the com-

TABLE I. The locations, elevations, and areas of the ponds which were surveyed

Name of Pond	Pond No.	Township and County, or County	Elevation above sea level: feet	Area: acres
Stanley Pond	155	Hiram and Porter, Oxford	381	137
Trafton Pond	156	Hiram and Porter, Oxford	388	56
Barker Pond	169	Hiram, Oxford	491	206
Granger Pond	180	Denmark, Oxford	525	125
Moose Pond Lower	179	Denmark, Oxford	418	388
Middle	181	Denmark in Oxford and Bridgton in Cumberland	418	941
Upper	182	Bridgton in Cumberland and Sweden in Oxford	418	365
Beaver Pond	183	Bridgton, Cumberland	473	69
Burnt Meadow Pond	195	Brownfield, Oxford	372	69
Long Pond	211	Denmark, Oxford	404	81
Kezar Lake Lower Bay	233	Lovell, Oxford	376	684
Middle and Upper Bay	238	Lovell, Oxford	376	1,826
Sebago Lake	291	Cumberland	262	28,771
Peabody Pond	302	Bridgton, Naples and Sebago in Cumberland	460+	735
Trickey Pond	303	Naples, Cumberland	360+	311
Adams Pond	307	Bridgton, Cumberland	640+	112
Long Lake	309	Cumberland	267	4,867
Wood Pond	313	Bridgton, Cumberland	456	442
Highland Lake	314	Bridgton, Cumberland	426	1,401
Stearns Pond	315	Sweden, Oxford	444	255
Moose Pond	319	Waterford, Oxford	555	181
Bear Pond	321	Waterford, Oxford	375	218
Keoka Lake	322	Waterford, Oxford	492	467
Crystal Lake or Anonymous Pond	324	Harrison, Cumberland	294	461
Pleasant Lake	327	Otisfield and Casco, Cumberland	425	1,077
Long Pond or McWain Pond	332	Waterford, Oxford	533	473
Hutchinson Pond	337	Albany, Oxford	916	93
Thomas Pond	356	Casco and Raymond, Cumberland	275	442
Panther Pond	357	Raymond, Cumberland	277	1,439
Rattlesnake Pond or Crescent Lake	359	Raymond and Casco, Cumberland	277	822
Coffee Pond	362	Casco, Cumberland	460+	137

TABLE II. Water analyses. Vertical distribution of temperature, oxygen, and pH in 29 lakes and ponds, from analyses* made during the summer of 1938

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
STANLEY POND, P. 155, Hiram Twp., Oxford Co.	Surface	75.9	9.2	6.9
August 24, 11:30 A.M. to 1:15 P.M.	5	75.6	...	...
Station: near the center of the middle section of the pond	10	75.4	...	...
Depth of water: 70 ft.	15	74.5	...	...
	18	63.5	15.3	6.9
	20	57.6	...	...
	25	48.6	...	...
	30	42.1	8.9	6.1
	40	41.6	...	...
	50	40.5	4.0	6.1
	60	40.3	0.6	6.1
	70	40.3	0.1	5.9
TRAFTON POND, P. 156, Hiram Twp., Oxford Co.	Surface	71.9	8.9	6.9
August 25, 9:15 to 10:30 A.M.	5	71.8	...	...
Station: near the center of the pond.	10	71.8	...	...
Depth of water: 40 ft.	15	71.6	...	...
	18	61.2	10.4	6.3
	20	54.3	...	...
	25	47.8	...	...
	30	44.4	3.8	5.9
	40	43.0	0.2	5.9
Temperature at 42 ft. in bottom mud.	42	43.0	...	...
BARKER POND, P. 169, Hiram Twp., Oxford Co.	Surface	76.7	8.4	6.7
August 25, 2:00 to 3:15 P.M.	5	76.7	...	...
Station: about 1/8 mile off the southeast shore.	10	76.5	...	...
Depth of water: 40 ft.	15	76.3	...	...
	18	59.9	4.2	6.0
	20	54.7	...	...
	25	50.4	2.7	5.7
	30	47.1	...	...
	40	45.0	0.2	5.7
Temperature at 41 ft. in bottom mud.	41	44.8	...	...
GRANGER POND, P. 180, Denmark Twp., Oxford Co.	Surface	74	9.8	6.7
June 28, 10:30 to 11:00 A.M.	5	73	...	...
Station: near the center of the pond	10	73	9.2	6.7
Depth of water: 13 ft.	13	73	...	...

*All temperatures given to the nearest tenth of a degree were taken with a Negretti and Zambra Deep Sea Reversing Thermometer; all temperatures given to the nearest degree were taken with a Taylor Maximum and Minimum Thermometer. With few exceptions, all pH values of 5.5. to 6.3 inclusive were from tests made with Bromcresol Purple indicator, and all pH values of 6.4 to 7.1 were from tests made with Bromthymol Blue indicator; the exceptions are so indicated throughout this table. Each water analysis station is indicated by an ⊗ on the accompanying outline maps of these lakes.

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
MOOSE POND (lower part), P. 179, Denmark Twp., Oxford Co.	Surface	76.5	8.7	6.9
	10	76.5	...	...
July 15, 1:00 to 2:00 P.M.	13	71.8	...	...
Station: ½ mile east of Wood Island.	15	69.2	8.3	6.7
Depth of water: 27 ft.	18	68.0	...	...
	20	65.5	6.3	6.2
	23	58.8	3.7	5.9
	25	57.7	1.4	5.9
MOOSE POND (middle part), P. 181, Denmark Twp., Oxford Co.	Surface	76.1	...	6.9
	10	73.4	...	...
July 16, 1:15 to 2:15 P.M.	15	72.5	9.3	6.8
Station: just south of the center of the pond.	20	65.7	...	...
Depth of water: 31 ft.	25	62.8	9.0	6.4
	30	59.0	8.1	6.2
	31	56.7	...	...
MOOSE POND (middle part), P. 181, Bridgton, Twp., Cumberland Co.	Surface	75.4	9.2	6.9
	5	74.5	...	...
July 16, 10:30 to 11:45 A.M.	10	74.1	...	...
Station: just north of the center of the pond.	15	72.9	9.3	6.9
Depth of water: 64 ft.	20	67.5	...	...
	25	62.6	8.6	6.4
	30	56.7	...	...
	35	54.7	8.5	6.3*
	40	53.6	...	...
	50	52.5	8.0	6.1
	60	52.2	7.7	6.0
*pH 6.3 with Bromthymol Blue.	64	52.0	7.6	5.9
BEAVER POND, P. 183, Bridgton Twp., Cumberland Co.	Surface	76.8	8.7	6.9
	5	75.7	...	...
July 25, 11:45 A.M. to 1:45 P.M.	10	73.2	8.4	6.9
Station: near the center of the pond.	12	68.2	...	...
Depth of water: 31 ft.	13	65.8	7.8	6.5
	15	60.9	...	...
	18	54.5	2.7	5.9
	20	53.8	...	...
	25	47.7	...	...
	30	45.9	0.0	5.9
	31	47.5?	...	...
BEAVER POND, P. 183, Bridgton Twp., Cumberland Co.	Surface	76.6	...	...
	5	74.7	...	...
July 25, 2:15 to 2:45 P.M.	10	71.8	...	...
Station: 0.1 mile off the east shore.	12	69.3	...	...
Depth of water: 20 ft.	13	66.4	...	...
	15	61.2	...	...
	18	55.0	...	...
	20	52.5	...	...

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
BURNT MEADOW POND, P. 195, Brownfield Twp., Oxford Co.	Surface	78	9.2	6.9
July 14, 12:00 M. to 1:30 P.M.	1	75	...	...
Station: half-way between island and the southeast shore.	2	75	...	...
Depth of water: 44 ft.	5	73	...	...
	7	71	...	...
	8	70	...	...
	9	69	...	...
	10	66	10.6	6.8
	11	62	...	...
	12	60	...	...
	13	58	...	...
	14	55	...	...
	15	53	...	...
	17	50	...	...
	20	48	7.7	6.0
	25	46	...	...
	30	45	5.5	5.9
	35	43	...	...
	40	42	1.1	5.8
	44	42	...	...
LONG POND, P. 211, Denmark Twp., Oxford Co.	Surface	78	9.3	6.8
July 11, 12:45 to 1:30 P.M.	1	76	...	...
Station: ¼ mile from the north end of the pond.	2	76	...	...
Depth of water: 18 ft.	3	76	...	...
	5	75	...	...
	10	73	9.8	6.8
	12	71	...	...
	15	70	...	...
	16	69	10.6	6.6
	18	66	...	...
LONG POND, P. 211, Denmark Twp., Oxford Co.	Surface	78	9.4	6.8
July 11, 1:40 to 2:30 P.M.	1	76	...	...
Station: ¼ mile from the south end of the pond.	2	75	...	...
Depth of water: 18 ft.	3	74	...	...
	5	74	...	...
	10	73	...	...
	15	72	...	...
	16	72	9.8	6.8
	18	71	...	...
KEZAR LAKE P. 238, Lovell Twp., Oxford Co.	Surface	79	...	...
July 20, 1:45 to 2:15 P.M.	5	76	...	...
Station: 1 mile southwest of Browns Camp.	10	76	...	...
Depth of water: 22 ft.	12	74	...	...
	15	72	...	...
	18	69	...	...
	20	65	...	...
	22	62	...	...
KEZAR LAKE, P. 238, Lovell Twp., Oxford Co.	Surface	76.3	9.0	6.9
July 20, 1:30 to 2:00 P.M.	5	74.5	...	...
Station: 0.7 mile south of Browns Camp.	10	74.3	...	...
Depth of water: 24 ft.	15	72.7	9.2	6.8
	20	67.5	9.3	6.6
	24	61.9	8.1	6.2

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
KEZAR LAKE, P. 238, Lovell Twp., Oxford Co.	Surface	77	...	...
July 20, 10:15 to 11:00 A.M.	5	74	...	...
Station: in the narrows at Browns Camp.	10	74	...	...
Depth of water: 26 ft.	15	72	...	...
	16	70	...	...
	17	69	...	...
	18	69	...	...
	19	68	...	...
	20	65	...	...
	21	64	...	...
	25	60	...	...
	26	57	...	...
KEZAR LAKE, P. 238, Lovell Twp., Oxford Co.	Surface	74.3	9.1	6.9
July 20, 9:30 to 11:30 A.M.	15	72.5	...	...
Station: ¼ mile off the mouth of Mill Brook.	20	67.6	9.4	6.6
Depth of water: 78 ft.	25	59.0	...	...
	30	54.3	...	...
	35	51.6	...	...
	40	49.3	...	...
	50	45.7	10.2	6.1
	60	43.9	...	...
	70	43.0	10.0	6.0
	78	42.4	10.0	6.0
KEZAR LAKE, P. 238, Lovell Twp., Oxford Co.	Surface	75.6	9.1	6.9
July 19, 11:30 A.M. to 2:30 P.M.	15	73.2	...	...
Station: 0.2 mile off the east shore, opposite Bryant Hill.	20	66.9	9.8	6.7
Depth of water: 147 ft.	25	59.0	...	...
	30	54.5	...	...
	35	52.3	...	...
	40	50.0	...	...
	50	46.9	10.3	6.1
	60	44.5	...	...
	70	43.5	...	...
	80	42.8	...	...
	90	42.6	...	...
	100	42.4	10.1	6.0
	110	42.3	...	...
	120	42.3	10.0	6.0
	130	42.3	...	...
	140	42.3	9.7	6.0
*Thermometer at 147 feet was in the bottom mud.	145	...	9.5	6.0
	147	41.4*	...	...
SEBAGO LAKE, P. 291, Casco Twp., Cumberland Co.	Surface	81	8.9	7.1
August 4, 1:30 to 3:00 P.M.	20	77	...	...
Station: 0.2 mile south of Bear Point.	25	72.9	9.2	6.9
Depth of water: 74 ft.	30	64.2	...	...
	35	53.2	...	...
	40	50.0	11.5	6.5
	50	47.1	11.8	6.5
	60	46.2	11.9	...
	70	45.5	12.0	...
	74	45.0	...	...

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
SEBAGO LAKE, P. 291, Cumberland Co.	Surface	78	9.0	6.9
Aug. 8, 12:30 to 4:30 P.M.	20	77	...	...
Station: 2 miles east of North Sebago village.	25	69.3	9.4	6.8
Depth of water: 300 ft.	30	59.2	...	...
	35	56.8	...	...
	40	52.9	11.3	6.6
	50	48.4	...	...
	60	47.1	...	...
	70	45.7	...	...
	80	45.1	12.2	6.6
	90	44.4	...	...
	100	43.9	12.4	6.6
	125	42.4	...	...
	150	42.1	12.8	6.6
	175	41.7	...	...
	200	41.7	12.8	6.6
	250	41.2	...	...
	280	41.0	12.7	6.5
	290	...	12.7	6.5
	300	41.0	12.7	6.5
SEBAGO LAKE, P. 291, Naples Twp., Cumberland Co.	Surface	78	8.7	7.1
Aug. 9, 10:15 to 11:45 A.M.	20	71.8	...	...
Station: ½ mile northeast of Wards Point.	25	65.7	9.3	6.8
Depth of water: 130 ft.	40	52.1	11.3	6.7
	60	47.1	...	...
	80	44.1	12.1	6.7
	100	42.8	...	...
	110	42.6	...	...
	120	42.4	...	...
	130	42.3	12.3	6.7
SEBAGO LAKE, P. 291, Naples Twp., Cumberland Co.	Surface	78	8.9	7.1
Aug. 9, 12:30 to 1:30 P.M.	20	78	...	...
Station: ½ mile off Long Beach.	25	77	9.2	6.7
Depth of water: 106 ft.	30	76	...	...
	35	57.2	...	...
	40	53.2	11.2	6.6
	60	47.5	...	...
	80	45.1	12.2	6.6
	90	44.2	...	...
	106	43.9	12.2	6.6
SEBAGO LAKE, P. 291, Standish Twp., Cumberland Co.	Surface	80	9.1	7.1
Aug. 5, 2:30 to 4:45 P.M.	20	72.3	...	...
Station: 0.3 mile north of Indian Island.	25	70.9	9.4	6.9
Depth of water: 142 ft.	30	69.6	...	...
	35	61.2	...	...
	40	54.1	11.1	6.6
	50	49.3	...	...
	60	47.3	11.5	6.5
	70	46.9	...	...
	80	46.4	11.7	6.4*
	90	46.2	...	...
	100	46.0	11.7	6.4*
	110	45.9	...	...
	120	45.7	11.3	6.4*
	130	45.5	11.5	6.4*
*pH tests of 6.4 with Bromcresol Purple.	140	45.3	11.4	6.4*

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
SEBAGO LAKE, P. 291, Raymond Twp., Cumberland Co.	Surface	79	9.2	7.1
Aug. 4, 4:00 to 4:30 P.M.	20	76.5	...	...
Station: 0.3 mile west of Whites Point.	25	71.2	...	...
Depth of water: 82 ft.	30	62.8	...	...
	35	52.2	...	...
	40	48.6	11.3	6.5
	50	47.8	...	...
	60	47.1	...	...
	70	46.6	11.7	6.5
	80	46.2	11.7	6.5
PEABODY POND, P. 302, Naples Twp., Cumberland Co.	Surface	72.7	9.9	6.8
July 8, 12:45 to 2:00 P.M.	5	69.6	...	...
Station: just north of the center of the pond.	10	69.3	...	...
Depth of water: 56 ft.	15	67.5	...	...
	20	64.9	10.4	6.7
	23	57.9	...	...
	25	55.4	...	...
	28	53.6	...	...
	30	53.4	...	...
	33	51.6	8.7	6.0
	35	51.6	...	...
	38	51.4	...	...
	40	50.9	...	...
	45	50.7	8.2	5.9
	50	49.8	...	...
	56	49.7	7.5	5.9
PEABODY POND, P. 302, Sebago Twp., Cumberland Co.	Surface	72.7	10.0	6.8
July 8, 2:45 to 4:00 P.M.	5	71.1	...	...
Station: 0.3 mile north of the outlet.	10	68.5	...	...
Depth of water: 62 ft.	15	67.6	...	...
	20	63.3	10.5	6.5
	23	59.2	...	...
	25	55.6	...	...
	28	55.1	...	...
	30	53.4	...	...
	33	52.5	9.6	6.1
	35	52.0	...	...
	38	51.4	...	...
	40	50.7	...	...
	45	50.2	8.4	5.9
	50	49.7	...	...
	55	49.3	...	...
	59	49.1	7.1	5.9
PEABODY POND, P. 302, Naples Twp., Cumberland Co.	Surface	73	...	...
July 8, 4:15: to 4:30 P.M.	5	71	...	...
Station: in the center of the southwest bay.	10	69	...	...
Depth of water: 44 ft.	15	68	...	...
	20	57	...	...
	23	54	...	...
	25	53	...	...
	28	53	...	...
	30	52	...	...
	33	52	...	...
	35	51	...	...
	38	51	...	...
	40	51	...	...
	44	51	...	...

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
TRICKEY POND, P. 303, Naples Twp., Cumberland Co.	Surface	77.9	8.8	6.7
Aug. 16, 10:00 A.M. to 1:45 P.M.	5	76.8	...	...
Station: near the center of the pond.	10	76.3	...	...
Depth of water: 54 ft.	15	75.4	...	...
	20	74.5	8.9	6.7
	25	73.2	10.3	6.7
	28	64.2	...	...
	30	62.6	11.7	6.6
	32	60.4	...	...
	35	56.5	11.4	6.3
	40	54.7	10.4	6.1
	45	52.2	7.7	5.9
	50	50.2	4.2	5.8
ADAMS POND, P. 307, Bridgton Twp., Cumberland Co.	Surface	71	9.8	7.0
July 1, 1:30 to 3:15 P.M.	5	71	...	...
Station: about ⅛ mile west of the center of the pond.	10	71	...	...
Depth of water: 50 ft.	12	70	...	...
	13	66	12.4	7.0
	14	65	...	...
	15	64	...	...
	16	62	...	...
	17	59	...	...
	18	55	...	...
	19	53	...	...
	20	51	...	...
	21	50	...	...
	22	49	...	...
	23	48	...	...
	24	47	...	...
	25	46	...	...
	26	45	...	...
	27	44	8.9	6.3*
	28	44	...	...
	29	44	...	...
	30	44	...	...
	35	44	4.2	6.0
	40	43	...	...
	45	43	...	...
*pH test of 6.3 with Bromthymol Blue.	50	43	1.9	5.9
ADAMS POND, P. 307, Bridgton Twp., Cumberland Co.	Surface	74.7	9.2	7.1
Aug. 14, 12:15 to 1:15 P.M.	5	74.3	...	...
Station: in the center of the pond.	10	74.1	...	...
Depth of water: 39 ft.	15	73.8	9.2	7.0
	18	65.8	...	...
*pH tests of 6.1 and 6.2 with Bromthymol Blue.	20	60.3	...	...
	22	56.5	...	...
	25	50.9	8.9	6.2*
Probable contamination in oxygen sample at 37 feet.	30	46.2	4.9	6.1*
	35	44.4	1.3	6.1*
	37	44.1	1.9	...

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
LONG LAKE, P. 309, Naples Twp., Cumberland Co.	Surface	69	9.8	6.8
July 6, 10:30 A.M. to 12:00 M.	5	69	...	...
Station: 1 mile northwest of Naples.	10	69	...	...
Depth of water: 40 ft.	15	69	...	...
	20	69	9.8	6.8
	25	69	...	...
	30	69	...	...
	35	69	9.8	6.8
	38	66	9.4	6.7
	40	62	8.5	6.6
LONG LAKE, P. 309, Naples Twp., Cumberland Co.	Surface	69	10.1	6.8
July 6, 2:30 to 4:00 P.M.	5	69	...	...
Station: just off Long Point.	10	69	...	...
Depth of water: 34 ft.	15	69	...	...
	20	68	9.6	6.8
	21	66	...	...
	22	64	...	...
	23	64	...	...
	24	64	...	...
	25	62	8.7	6.7
	26	60	...	...
	27	60	8.1	6.5
	30	59	...	...
*pH of 6.3 with Bromthymol Blue.	34	58	7.8	6.3*
LONG LAKE, P. 309, Cumberland Co.	Surface	72.9	9.7	6.8
July 7, 1:00 to 3:00 P.M.	5	69.4	...	...
Station: 1 mile north of Long Point.	10	68.7	...	...
Depth of water: 43 ft.	15	68.5	...	...
	20	68.4	9.7	6.8
	25	67.8	...	...
	28	65.7	...	...
	30	64.6	8.4	6.3
	33	63.9	...	...
	35	63.5	8.0	6.3
	38	62.6	...	...
	40	62.4	...	...
	43	62.4	7.3	6.2
LONG LAKE, P. 309, Harrison Twp., Cumberland Co.	Surface	73	...	...
July 7, 2:00 to 2:30 P.M.	1	71	...	...
Station: ¼ mile north of Bluff Point.	2	70	...	...
Depth of water: 48 ft.	5	68	...	...
	10	68	...	...
	15	68	...	...
	20	66	...	...
	22	65	...	...
	25	62	...	...
	26	62	...	...
	27	62	...	...
	30	61	...	...
	33	59	...	...
	35	58	...	...
	40	58	...	...
	45	56	...	...
	48	55	...	...

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
LONG LAKE, P. 309, Harrison Twp., Cumberland Co. July 7, 3:00 to 3:50 P.M. Station: 1 mile north of Bluff Point. Depth of water: 55 ft.	Surface	72	...	...
	1	72	...	...
	2	70	...	...
	3	69	...	...
	5	68	...	...
	10	68	...	...
	15	68	...	...
	20	66	...	...
	22	66	...	...
	23	65	...	...
	25	63	...	...
	27	62	...	...
	30	61	...	...
	33	59	...	...
	35	58	...	...
	40	58	...	...
	45	57	...	...
	50	57	...	...
	55	55	...	...
WOOD POND, P. 313, Bridgton Twp., Cumberland Co. June 23, 2:30 to 3:30 P.M. Station: ½ mile north of the outlet, half way between the east and west shores. Depth of water: 27 ft.	Surface	83	8.9	6.4
	3	77	...	...
	5	76	...	...
	8	73	...	...
	10	70	9.2	6.2
	13	66	...	...
	15	62	8.5	6.0
	18	59	...	...
	20	58	6.8	5.8
	23	58	...	...
	24	...	6.3	5.7
	25	57	...	...
	27	57	...	...
WOOD POND, P. 313, Bridgton Twp., Cumberland Co. June 23, 11:00 A.M. to 1:00 P.M. Station: ¾ mile south of the north end of the pond. Depth of water: 23 ft.	Surface	81	8.5	6.4
	3	78	...	...
	5	76	...	...
	8	72	...	...
	10	70	8.9	6.2
	13	67	...	...
	15	62	8.9	6.1
	18	58	...	...
	20	58	7.0	5.8
	23	58	...	...
WOOD POND, P. 313, Bridgton Twp., Cumberland Co. Aug. 3, 5:00 to 5:45 P.M. Station: ½ mile north of the outlet, ⅛ mile off the west shore. Depth of water: 25 ft.	Surface	79	8.4	6.7
	5	77.4	...	...
	10	75.2	...	...
	15	71.2	5.7	6.0
	18	67.5	4.2	5.9
	20	64.2	...	...
	22	62.8	2.6	5.7
	24	61.3	1.7	5.5

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
HIGHLAND LAKE, P. 314, Bridgton Twp., Cumberland Co.	Surface	73	9.4	6.8
June 29, 1:15 to 3:15 P.M.	5	73	...	...
Station: 1¼ miles above the outlet.	10	72	...	...
Depth of water: 46 ft.	15	68	8.8	6.6
	18	64	...	...
	20	60	7.8	6.2
	23	59	...	...
	25	58	...	...
	30	57	6.4	6.1
	40	56	...	...
	46	55	5.0	6.0
HIGHLAND LAKE, P. 314, Bridgton Twp., Cumberland Co.	Surface	73	9.4	6.8
June 29, 4:00 to 4:30 P.M.	10	73	9.3	6.8
Station: ¼ mile south of the point in the upper part of the lake.	13	70	...	...
Depth of water: 25 ft.	15	65	8.1	6.3
	18	61	...	...
	20	59	7.3	6.2
	25	58	6.4	6.1
HIGHLAND LAKE, P. 314, Bridgton Twp., Cumberland Co.	Surface	76.1	8.0	6.7
Aug. 20, 10:45 to 11:45 A.M.	5	75.0	...	...
Station: 1½ miles above the outlet.	10	74.7	...	...
Depth of water: 44 ft.	15	74.5	...	...
	20	73.4	7.5	6.5
	25	65.7	2.3	6.1
	30	62.8	...	...
	35	58.6	0.1	5.9
	40	58.3	0.0	...
	44	57.6	...	5.9
STEARNS POND, P. 315, Sweden Twp., Oxford Co.	Surface	77.5	8.7	6.8
July 27, 9:30 to 10:30 A.M.	5	76.1	...	...
Station: ¼ mile north of the outlet.	10	73.6	...	...
Depth of water: 45 ft.	15	68.2	...	...
	18	60.6	6.4	6.1
	20	57.0	...	...
	25	54.1	6.0	6.0
	30	52.2	...	...
	40	50.0	2.1	5.8
	45	49.6	1.4	5.7
MOOSE POND, P. 319, Waterford Twp., Oxford Co.	Surface	75.2	9.1	6.8
July 29, 11:30 A.M. to 1:00 P.M.	5	75.0	...	...
Station: ¾ mile above the outlet.	10	75.0	...	...
Depth of water: 39 ft.	15	73.2	...	...
	18	68.0	...	...
	20	62.6	9.7	6.3
	22	59.7	...	...
	25	54.7	5.2	6.1
	30	51.4	...	...
	35	48.6	...	...
	39	47.8	0.2	5.8
MOOSE POND, P. 319, Waterford Twp., Oxford Co.	Surface	75.2	9.1	6.8
July 29, 1:30 to 2:30 P.M.	5	75.2	...	...
Station: near the center of the pond	10	75.2	...	...
Depth of water: 33 ft.	15	73.2	...	...
	18	68.2	...	...
	20	63.1	10.4	6.6
	22	59.7	...	...
	25	54.9	4.3	5.9
	30	50.7	...	...
	33	49.6	0.4	5.7

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
BEAR POND, P. 321, Waterford Twp., Oxford Co.	Surface	76.3	9.2	7.0
July 28, 12:00 M. to 1:00 P.M.	5	76.3	...	...
Station: ⅛ mile off the middle of the east shore.	10	72.1	...	...
Depth of water: 58 ft.	15	65.5	...	...
	20	57.4	8.2	6.2
	25	51.1	...	...
	30	47.7	...	...
	35	45.3	...	...
	40	43.7	8.4	6.1
	50	42.1	6.9	6.0
	58	41.5	5.0	5.9
KEOKA LAKE, P. 322, Waterford Twp., Oxford Co.	Surface	78	8.8	6.9
Aug. 1, 4:00 to 5:15 P.M.	5	78	...	...
Station: ⅛ mile north of the point in the southwest shore of the pond.	10	77	...	...
Depth of water: 37 ft.	12	72.1	...	...
	15	70.3	...	...
	18	62.4	7.8	6.4
	20	59.2	...	...
	22	57.2	...	...
	25	54.5	5.1	6.1
	30	52.7	3.3	6.0
	35	51.4	1.8	6.0
	37	50.9	...	...
CRYSTAL LAKE or ANONYMOUS POND, P. 324, Harrison Twp., Cumberland Co.	Surface	78	8.8	6.9
July 27, 12:15 to 1:30 P.M.	5	76.8	...	...
Station: ½ mile north of the outlet.	10	75.4	...	...
Depth of water: 58 ft.	12	72.0	...	...
	15	70.5	...	...
	18	64.6	8.2	6.4
	20	60.8	...	...
	25	55.4	...	...
	30	49.3	7.0	6.1
	40	46.2	...	...
	45	46.0	6.0	5.9
	55	...	5.4	5.9
	58	46.0	...	...
CRYSTAL LAKE or ANONYMOUS POND, P. 324, Harrison Twp., Cumberland Co.	Surface	79	...	...
July 26, 4:45 to 5:40 P.M.	5	76.6	...	...
Station: 0.4 mile southwest of the mouth of Sucker Brook.	10	74.1	...	...
Depth of water: 62 ft.	15	72.7	...	...
	18	64.0	...	...
	20	57.9	...	...
	25	52.5	...	...
	30	50.4	...	...
	40	46.8	...	...
	50	46.0	...	...
	60	45.7	...	...
	62	45.7	...	...
PLEASANT LAKE, P. 327, Casco and Otisfield Twps., Cumberland Co.	Surface	74.7	9.2	7.1
Aug. 13, 10:00 A.M. to 12:00 M.	5	74.1	...	...
Station: 1 mile north of the outlet.	10	73.9	...	...
Depth of water: 59 ft.	15	73.8	...	...
	20	73.0	...	...
	25	71.6	...	...
	30	68.9	9.7	6.9
	35	62.1	...	...
	40	56.5	9.2	6.8
	50	54.7	2.9	6.1
	59	54.5	2.9	6.1

TABLE II. Water analyses — Continued

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
LONG POND or McWAIN POND, P. 332, Waterford Twp., Oxford Co.	Surface	81	8.6	6.8
Aug. 3, 1:30 to 2:50 P.M.	5	77.2	...	...
Station: ¾ mile north of the south end of the pond.	10	76.1	...	...
Depth of water: 38 ft.	15	73.9	...	...
	18	72.1	...	...
	20	68.4	...	...
	22	64.8	7.3	6.2
	25	60.4	...	...
	30	56.5	3.9	5.9
	35	55.0	2.3	5.9
	38	54.7	2.3	5.9
HUTCHINSON POND, P. 337, Albany Twp., Oxford Co.	Surface	76.6	8.7	6.6
Aug. 2, 12:00 M. to 1:30 P.M.	5	76.1	...	...
Station: ⅛ mile off the northeast shore.	10	75.0	...	...
Depth of water: 35 ft.	15	68.5	...	...
	18	63.9	4.9	5.8
	20	60.3	...	...
	23	55.8	...	...
	25	54.0	0.7	5.7
	30	50.4	0.1	5.7
	35	49.1	0.0	5.7
THOMAS POND, P. 356, Raymond Twp., Cumberland Co.	Surface	78	8.3	6.9
Aug. 17, 9:30 to 11:00 A.M.	5	78	...	...
Station: ⅛ mile off the southeast shore.	10	75.0	...	...
Depth of water: 63 ft.	15	73.9	...	...
	20	68.4	4.6	6.5
	22	63.3	...	...
	25	60.3	2.7	6.1
	28	57.4	...	...
	30	56.3	1.9	6.1
	35	53.6	...	...
	40	50.9	2.3	6.1
	50	48.9	1.5	6.0
	60	48.0	0.9	6.0
THOMAS POND, P. 356, Raymond Twp., Cumberland Co.	Surface	75.7	8.6	7.0
Aug. 18, 11:00 A.M. to 1:00 P.M.	5	75.7	...	...
Station: same as on Aug. 17.	10	75.7	...	...
Depth of water: 62 ft.	15	75.0	8.1	6.8
	20	69.4	4.3	6.2
	22	63.9	...	...
	25	59.5	1.8	6.1
	28	57.2	...	...
	30	56.7	1.8& 1.4	6.1
	35	54.9	...	...
	40	52.5	2.7& 2.7	6.0
	45	50.2	...	...
	50	48.9	1.2	5.9
	55	48.2	...	...
	60	48.0	0.6	5.9

TABLE II. Water analyses — Concluded

Pond, pond number, location, date, time, station and water depth	Depth in feet	Temperature: ° F.	Oxygen: p.p.m.	pH
PANTHER POND, P. 357, Raymond Twp., Cumberland Co.	Surface	78	8.7	7.0
Aug. 22, 3:00 to 4:30 P.M.	5	77.4	...	...
Station: near the center of the northern half of the lake.	10	76.5	...	...
Depth of water: 68 ft.	15	75.6	...	...
	20	74.1	...	...
	25	66.7	5.7	6.4*
	30	59.7	...	...
	35	55.9	4.0	6.2
	40	54.7	...	...
	50	53.4	4.0	6.1
	60	50.4	...	...
*pH of 6.4 with Bromcresol Purple.	68	49.1	1.4	6.1
RATTLESNAKE POND (CRESCENT LAKE), P. 359, Casco Twp., Cumberland Co.	Surface	76.5	8.6	7.0
Aug. 22, 11:15 A.M. to 12:45 P.M.	5	76.5	...	...
Station: ¾ mile south of the north end of the pond.	10	76.5	...	...
Depth of water: 50 ft.	15	76.3	...	...
	20	76.1	4.0	6.9
	25	70.3	3.4	6.5
	28	63.9	...	...
	30	61.7	...	...
	35	57.9	0.0	6.3
	40	56.1	...	...
	48	...	0.0	6.3
	50	54.5	...	...
COFFEE POND, P. 362, Casco Twp., Cumberland Co.	Surface	76.5	9.2	7.0
Aug. 15, 10:00 A.M. to 1:15 P.M.	5	76.1	...	...
Station: near the center of the pond.	10	75.7	...	...
Depth of water: 63 ft.	15	75.4	...	...
	20	74.8	9.3	7.0
	22	74.3	...	...
	25	67.3	...	...
	28	60.3	...	...
	30	57.2	...	...
	35	51.4	12.6	6.5
	40	47.8	...	...
	45	46.2	10.6	6.1
	50	45.0	5.7	5.8
	55	44.4	4.6	5.8
	60	44.4	3.9	5.8
	63	44.4	...	...

TABLE III. Partial summary of depth, temperature, and oxygen data for the ponds

Name of pond	Pond No.	Date of analyses: 1938	Maximum depth of pond: feet	Depth in feet above which temperature in excess of 70° F.		Depth in feet below which oxygen less than 5 p.p.m.	
				As of analyses	During most critical summer period (estimated)	As of analyses	During most critical summer period (estimated)
Stanley Pond	155	Aug. 24	75	16	18	45	42
Trafton Pond	156	Aug. 25	43	16	18	25	24
Barker Pond	169	Aug. 25	44	16	18	17	17
Granger Pond	180	June 28	28	14	18	26	20
Moose Pond Lower	179	July 15	33	14	20	21	20
Middle	181	July 16	70	17	25	64 (bottom)	bottom
Upper	182	None	18	bottom (estimated)	bottom	..	..
Beaver Pond	183	July 25	35	11	15	15	15
Burnt Meadow Pond	195	July 14	45	8	15	30	25
Long Pond	211	July 11	22	15 and 18	22 (bottom)	18 (bottom)	22 (bottom)
Kezar Lake Lower Bay	233	None	17	bottom (estimated)	bottom	..	..
Middle and Upper Bay	238	July 19 and 20	155	17	25	147 (bottom)	bottom
Sebago Lake	291	Aug. 4 to 9	316	26 (average)	30	300 (bottom)	bottom
Peabody Pond	302	Aug. 8	64	6	20	59 (bottom)	bottom
Trickey Pond	303	Aug. 16	57	26	26	47 (bottom)	45
Adams Pond	307	July 1 & Aug. 14	51	16	18	29	28
Long Lake	309	July 6 and 7	59	4	25	40 (bottom)	bottom
Wood Pond	313	June 23 & Aug. 3	29	16	17	17	17
Highland Lake	314	June 29 & Aug. 20	50	22	25	24	24
Stearns Pond	315	July 27	47	13	16	28	22
Moose Pond	319	July 29	43	17	19	24	22
Bear Pond	321	July 28	72	12	15	58 (bottom)	50
Keoka Lake	322	Aug. 1	42	15	16	25	22
Crystal Lake or Anonymous Pond	324	July 26 and 27	65	15	18	58 (bottom)	50
Pleasant Lake	327	Aug. 13	62	28	28	45	42
Long Pond or McWain Pond	332	Aug. 3	42	19	20	26	24
Hutchinson Pond	337	Aug. 2	40	13	15	18	15
Thomas Pond	356	Aug. 17	64	19	20	19	19
Panther Pond	357	Aug. 22	67	22	23	27	27
Rattlesnake Pond or Crescent Lake	359	Aug. 22	50	25	25	20	18
Coffee Pond	362	Aug. 15	70	24	24	53	50

TABLE IV. An evaluation of the ponds with respect to the suitability of temperature and of oxygen content of the water for trout and salmon during the most critical, late summer period

Name of Pond	Pond Number	How much of pond is, and is not, available to trout or salmon during most critical late summer period*											
		Volume of water						Area of bottom					
		Acre feet			% of total			Acres			% of total		
		Upper: warm, non-trout, above 70°F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower: oxygen deficient, non-trout	Upper: warm, non-trout, above 70° F.	Middle layer: trout or salmon water	Lower:oxygen deficient, non-trout
Stanley Pond	155	2,094	1,608	544	49	38	13	40	56	41	29	41	30
Trafton Pond	156	732	128	115	75	13	12	29	11	16	52	20	28
Barker Pond	169	2,496	0	1,179	70	0	33	125	0	96	61	0	47
Granger Pond	180	1,478	66	75	91	4	5	87	10	28	70	8	22
Moose Pond Lower	179	4,280	0	342	93	0	7	309	0	79	80	0	20
Middle	181	18,450	7,894	0	70	30	0	389	552	0	41	59	0
Upper	182	1,464	0	0	100	0	0	365	0	0	100	0	0
Beaver Pond	183	657	0	153	81	0	19	48	0	21	70	0	30
Burnt Meadow Pond	195	750	227	93	70	21	9	36	19	14	52	28	20
Long Pond	211	946	0	0	100	0	0	81	0	0	100	0	0
Kezar Lake Lower Bay	233	5,555	0	0	100	0	0	684	0	0	100	0	0
Middle & Upper Bay	238	34,333	47,344	0	42	58	0	860	966	0	47	53	0

Sebago Lake	291	771,640	2,312,641	0	25	75	0	5,983	22,788	0	21	79	0
Peabody Pond	302	13,007	10,155	0	56	44	0	166	569	0	23	77	0
Trickey Pond	303	6,448	2,989	902	62	29	9	121	63	127	39	20	41
Adams Pond	307	1,596	483	242	69	21	10	45	35	32	40	31	29
Long Lake	309	94,042	31,235	0	75	25	0	2,111	2,756	0	43	57	0
Wood Pond	313	5,927	0	1,509	80	0	20	179	0	263	41	0	59
Highland Lake	314	23,497	0	3,196	90	0	12	867	0	572	62	0	41
Stearns Pond	315	3,557	1,042	1,929	55	16	29	64	34	157	25	13	62
Moose Pond	319	2,869	335	741	73	8	19	58	22	101	32	12	56
Bear Pond	321	2,810	3,908	748	38	52	10	60	87	71	27	40	33
Keoka Lake	322	6,821	2,140	3,126	56	18	26	80	60	327	17	13	70
Crystal Lake or Anonymous Pond	324	7,326	6,609	740	50	45	5	106	249	106	23	54	23
Pleasant Lake	327	23,203	6,421	3,144	71	19	10	474	275	328	44	26	30
Long Pond or McWain Pond	332	7,840	1,147	1,962	72	10	18	157	58	258	33	12	55
Hutchinson Pond	337	995	0	247	80	0	20	50	0	43	54	0	46
Thomas Pond	356	6,841	0	2,774	73	0	30	205	0	260	46	0	59
Panther Pond	357	25,895	3,053	7,012	72	9	19	599	151	689	42	10	48
Rattlesnake Pond or Crescent Lake	359	15,895	0	6,813	83	0	36	370	0	560	45	0	68
Coffee Pond	362	2,880	1,647	293	60	34	6	33	71	33	24	52	24

*Based on estimated depths above which water is too warm (above 70° F.) and below which oxygen is deficient (less than 5 p.p.m.) for trout and salmon. Note overlap of upper into lower zones in some instances.

puted areas within critical depth contours.[6] Data for all ponds on the amount of water and bottom area which is, and is not available to trout and salmon are given in Table IV. The volume of water in each of the three layers (upper: warm; middle layer: trout water; and lower: oxygen deficient) is given in acre feet and in per cent of the total water volume of the lake; the amount of bottom area directly beneath and in contact with the water in each of these layers is given in acres and in per cent of the total bottom area. These data given in Table IV are of utmost importance to the development of an efficient stocking policy for trout or salmon, for they indicate in how much of each pond these fish can live during the most critical part of the summer. The 31 lakes and ponds which were studied during the present survey and which are listed in Table IV may be grouped, on the basis of the relative amount of trout water and the amount of bottom area available to trout, as follows:

Excellent trout water, 7 lakes and ponds: Sebago Lake, Middle and Upper Bays of Kezar Lake, Peabody Pond, Bear Pond, Crystal Lake or Anonymous Pond, the middle or main part of Moose Pond (P. 181), and Coffee Pond.

Good trout water, 6 lakes and ponds: Stanley Pond, Burnt Meadow Pond, Trickey Pond, Adams Pond, Long Lake (P. 309), and Pleasant Lake.

Fair trout water, 2 lakes and ponds: Trafton Pond and Keoka Lake.

Poor trout water, 5 ponds: Granger Pond, Stearns Pond, Moose Pond (P. 319), Panther Pond, and Long or McWain Pond.

Absolutely no trout water, 11 lakes and ponds: Barker Pond, lower part of Moose Pond (P. 179), upper part of Moose Pond (P. 182), Beaver Pond, Long Pond (P. 211), Lower Bay of Kezar Lake, Wood Pond, Highland Lake, Hutchinson Pond, Thomas Pond, and Rattlesnake Pond or Crescent Lake.

The above classification is the first step in evaluating these lakes and ponds according to their suitability for stocking with trout and salmon. This classification is not a particularly refined one, however, because of the impossibility of dividing a well graded series into groups—for example, Pleasant Lake which is listed as "good trout water" is only slightly better than Keoka Lake which is listed as "fair." Furthermore, this listing is based on only two factors (water and lake bottom), and not on the very important factors of abundance of competing warm-water game fishes and abundance of food organisms, which will be considered later.

[6]A more complete description of the methods used in computing the amount of water and lake bottom suitable for trout is given in the section on "Field and Laboratory Methods of Lake Survey," see Appendix B of this report.

PLANKTON OF THE LAKES

Plankton is a term used by limnologists to define the free-floating, mostly microscopic animals and plants which are to be found in practically all natural waters, both lakes and streams. These microscopic forms of life are of great importance as food for fishes. A few species of fishes feed mostly on plankton; the young of most fishes feed on it; and the adults of most game fishes feed on smaller fishes which, in turn, feed on plankton. Also, plankton forms an important part of the food of many fish-food organisms which live on the bottom of lakes and streams. In brief, the fish-producing capacity of any given body of water is dependent to a large extent upon the abundance of this basic plankton food supply.

Plankton samples were collected from 27 of the 31 lakes which were surveyed (see Table V). The samples were collected with a Birge Closing Net, and mostly while water analyses were being made and at the same place on each lake (see Table II). The net was hauled vertically and upward so as to strain organisms from a given column of water between any two desired depth levels. On most of the deeper lakes samples were taken separately for the deep water and the surface water. These collections have been analyzed in order to calculate the average numbers of different types of planktons and the average number and volume of all planktons per cubic foot of lake water (see Table V). These average numbers and volumes of planktons are averages for given depth ranges, and since planktons are known to be concentrated usually in the upper warm water (epilimnion), and since the depth ranges of the samples vary from lake to lake, the average plankton values for the various lakes are not all directly comparable; rather, the extent of each depth range should be taken into account in comparing one sample with another. Also, the samples can not be compared too precisely because only one series of samples was collected from many of the lakes, and limnologists have well established the fact that plankton populations vary seasonally and in different parts of a lake. It is believed, however, that the samples were sufficient to allow a gross classification of the various lakes on the basis of plankton abundance, and plankton abundance is here considered to be an index of the basic fish producing capacity of a lake.

The plankton organisms collected from these 27 lakes represented nine different groups of animals and plants. These major types, together with some of the more abundant genera, and notes on the plankton populations, are as follows:

COPEPODA. The copepods, together with the next type (cladocerans), are the most important of the plankton forms fed upon directly by small fishes. These water-fleas are also the largest and most active of the plankton forms. Mostly because of their large size and their dependence

TABLE V. The average numbers of different types of plankton, and the average volume of all plankton, per cubic foot of lake water within different lake strata as calculated from survey collections

Name and number of pond	Date: 1938 Time: A=A.M. P=P.M.	Depth range of sample in ft.	Average volume of plankton per cu. ft. of lake water in c.c.	Average number of plankton organisms per cu. ft. of lake water		In thousands — add ,000							
				Copepoda (water-fleas)	Cladocera (water-fleas)	Rotifera (rotifers)	Protozoa	Zoophyta	Desmidiaceae (desmids)	Chlorophyceae (other green algae)	Bacillarieae (diatoms)	Myxophyceae (blue-green algae)	All planktons
Stanley P. (P. 155)	Aug. 24 1:15P	60–30	0.05	47	95	....	7	....	....	11	14	....	32
Trafton P. (P. 156)	Aug. 25 10:30A	35–0	0.25	914	386	....	31	10	6	21	12	21	103
Barker P. (P. 169)	Aug. 25 3:15P	35–0	0.12	670	284	4	20	....	10	62	70	18	184
Moose P. (P. 179)	July 15 1:00P	20–0	0.31	3,342	2,370	7	87	5	9	200	46	18	377
Moose P.	July 16	25–0	0.18	1,323	170	....	27	11	5	74	22	6	147
(P. 181)	11:30A	50–25	0.05	170	19	2	16	....	2	18	20	9	67
Beaver P. (P. 183)	July 25 2:00P	30–0	0.11	616	411	2	46	....	....	17	9	3	77
Burnt Meadow P. (P. 195)	July 14 1:30P	40–0	0.21	392	356	5	43	5	....	55	82	12	203
Long P. (P. 211)	July 11 2:30P	16–0	0.49	6,267	800	....	243	....	....	137	....	38	426
Kezar L.	July 19	25–0	0.32	378	189	7	85	4	13	11	134	18	273
(P. 238)	3:00P	75–0	0.09	126	13	1	4	2	....	10	27	3	46
Sebago L.	Aug. 4	25–0	0.68	57	142	3	3	11	14	420	57	3	511
(P. 291)	2:30P	50–25	0.04	....	57	....	3	....	5	16	11	5	41
		70–50	0.07	71	36	....	....	3	....	34	14	....	51
	Aug. 9	25–0	0.24	170	114	....	3	....	8	85	19	38	153
	1:30P	50–25	0.14	114	28	....	....	5	3	25	22	14	68
		93–50	0.02	413	33	....	6	5	10	17	10	6	54
Peabody P.	July 8	25–0	0.09	454	85	5	3	....	....	....	25	5	39
(P. 302)	2:30P	55–25	0.06	....	24	2	5	2	....	....	5	23	36

Long L. (P. 309)	July 6 12:30P	35–0	0.16	518	193	2	4	1	1	18	58	33	117
	July 6 3:30P	34–0	0.17	125	146	2	....	2	....	2	24	2	32
	July 7 3:30P	38–0	0.09	477	56	1	8	13	2	20	53	38	134
Wood P. (P. 313)	June 23 1:00P	21–0	0.18	2,302	341	4	59	2	4	13	19	3	107
Highland L. (P. 314)	June 29 3:15P	35–0	0.20	677	108	3	31	....	1	12	43	17	107
	Aug. 20	20–0	0.28	923	213	10	7	3	7	92	3	7	131
	11:45A	35–20	0.10	2,559	332	....	32	....	9	146	27	9	226
Stearns P. (P. 315)	July 26 12:45P	46–0	0.05	268	41	1	3	....	....	24	16	4	48
Moose P. (P. 319)	July 29 1:00P	35–0	0.14	3,390	771	10	27	6	12	86	263	4	412
Bear P.	July 28	25–0	0.24	341	85	....	5	5	3	104	14	3	134
(P. 321)	2:00P	50–25	0.06	28	....	3	8	....	....	19	8	....	38
Keoka L. (P. 322)	Aug. 1 5:00P	30–0	0.18	1,161	190	....	57	....	....	91	11	30	190
Crystal L. or Anonymous P. (P. 324)	July 27 1:00P	55–0	0.05	827	52	2	7	1	2	15	....	17	47
Pleasant L.	Aug. 13	30–0	0.12	474	450	2	7	....	2	48	7	....	67
(P. 327)	11:45A	55–30	0.08	426	142	3	5	3	11	30	22	3	77
Long P. or McWain P. (P. 332)	Aug. 3 2:45P	25–0	0.14	369	85	....	11	....	....	44	8	16	80
Hutchinson P. (P. 337)	Aug. 2 1:40P	25–0	0.16	3,209	1,590	3	8	....	134	95	5	3	253
Thomas P.	Aug. 18	25–0	0.16	1,221	28	2	35	14	5	155	5	35	255
(P. 356)	12:15P	50–25	0.01	57	....	....	5	3	5	30	3	....	46
Panther P.	Aug. 22	25–0	0.17	454	312	....	11	....	3	82	3	19	118
(P. 357)	4:30P	60–25	0.06	629	....	....	....	....	....	4	21	6	32
Rattlesnake P. or Crescent L. (P. 359)	Aug. 22 12:45P	25–0	0.14	1,193	398	5	25	....	14	82	85	11	223
		45–25	0.03	36	....	....	3	....	....	3	10	3	20
Coffee P.	Aug. 15	25–0	0.26	540	284	....	5	....	16	101	46	24	195
(P. 362)	1:15P	50–25	0.20	170	57	5	136	14	5	186	19	60	426

upon plankton algae for food, the water-fleas do not obtain the enormous abundance of the algae. The maximum copepod population was encountered in Long Pond (P. 211) with 6,267 individuals per cubic foot. Many ponds had two to three thousand per cubic foot and most ponds had at least several hundred. The copepods were mostly *Diaptomus* and *Cyclops*. In several lakes the immature individuals or nauplii were far more abundant than the adult forms.

Cladocera. This second group of water fleas was considerably less abundant than the copepods in most lakes. However, they were sufficiently abundant to be very important as fish food. The greatest concentration was found in Lower Moose Pond (P. 179) with 2,370 individuals per cubic foot; while most ponds had several hundred or less. The cladocerans were represented by at least several species of *Daphnia*.

Rotifera. The rotifers are among the most highly organized of the extremely minute animals found abundantly in lakes. In general, they were found to be much more abundant than the water-fleas but less abundant than the algae. Five to ten thousand per cubic foot was the maximum abundance encountered. Among the most abundant genera were *Anuraea, Notholca, Conochilus,* and *Polyarthra.*

Protozoa. The protozoans are the lowest, smallest, and most simply organized of all the animals. Numerically, the protozoans make up a large portion of the total plankton population of lakes. A maximum concentration of 243,000 per cubic foot was found in Long Pond (P. 211). Several other ponds had over 50,000 per cubic foot. Among the many genera represented, *Dinobryon, Ceratium,* and *Synura* were most abundant; *Vampyrella, Mallomonas,* and *Actinophrys* were also present in considerable numbers.

Zoophyta. The term zoophyta is not of general use among biologists but is employed here to include several plankton forms which are claimed generally as plants by botanists and are included amongst the simplest animals by many zoologists. These zoophytes are of particular interest in that they reveal the great similarity between plant life and animal life in their simplest forms. Three genera of plankton encountered in the present study and referred to this group were *Pandorina, Eudorina,* and *Volvox.*

Desmidiaceae. The desmids were the least abundant of four groups of algae. They were found in an exceptional abundance of 134,000 per cubic foot in Hutchinson Pond. In most other ponds there were less than 10,000 per cubic foot. Most of the desmids were of the genus *Staurastrum;* other genera represented were *Xanthidium, Cosmarium* and *Closterium.*

CHLOROPHYCEAE. All green or grass-green algae, except the desmids, were included in this group. The green algae were, numerically, the most important of all the planktons. A maximum abundance of 420,000 was encountered in Sebago Lake. Many lakes had over 50,000 per cubic foot. Of the many genera represented *Micractinium* and *Ulothrix* were most abundant.

BACILLARIEAE. The diatoms were generally nearly as abundant as the green algae and exceeded the green algae in many lakes. A maximum population of 263,000 per cubic foot was found in Moose Pond (P. 319). *Asterionella, Tabellaria,* and *Fragellaria* were most abundant in the lakes as a whole.

MYXOPHYCEAE. The blue-green algae were generally third in abundance of the groups of algae. The maximum concentration of 60,000 per cubic foot was found in the deep water of Coffee Pond. In most lakes there were less than 30,000 per cubic foot. Among the most important genera were *Coelosphaerium, Anabena,* and *Merismopedia.*

The total plankton populations varied from a maximum concentration of 511,000 per cubic foot in the surface water of Sebago Lake (at one of two stations) to a minimum of 20,000 per cubic foot in the deeper water of Rattlesnake Pond (P. 359). The majority of the lakes had between 75,000 and 200,000 per cubic foot in the upper warm water. In general, but with several exceptions, the plankton was much more abundant, both numerically and in terms of total volume, in the upper warm-water layer (epilimnion) than in the deeper water.

The plankton producing capacity of this group of lakes of southern Maine appears to be about the same as that of the lakes of the Androscoggin, Saco, and Merrimac river watersheds in New Hampshire,[7] when figures on average volume of plankton are compared. When, however, the comparison is made with lakes in richer agricultural parts of the United States, these southern Maine lakes do not appear to be particularly rich; in fact, their plankton populations are far below those of many Wisconsin lakes[8] where periodic treatment with copper sulphate has been employed to keep the numbers of plankton algae in check. Also there is some evidence that some lakes in Maine are much richer in plankton than are the lakes covered by the present survey (see Quimby Pond under Appendix A of this report).

[7]Hoover, Earl E.: 1937. Biological survey of the Androscoggin, Saco and coastal watersheds. Survey Report No. 2, New Hampshire Fish and Game Department; and 1938. Biological survey of the Merrimac watershed. Survey Report No. 3, New Hampshire Fish and Game Department.

[8]Domogalla, Bernhard: 1936. Eleven years of chemical treatment of the Madison lakes:—its effect on fish and fish foods. Trans. Amer. Fish. Soc., Vol. 65, 1935 (1936), pp. 115-120.

These 27 Maine lakes are classified on the basis of plankton production into three categories (good, fair, poor) with the realization that "good" is probably far below the best possible grade for Maine lakes. This ranking is based collectively on three features of the plankton counts: (1) plankton volume, (2) abundance of copepods and cladocerans, and (3) total plankton count. The 27 lakes were grouped as follows:

Good plankton production: Sebago Lake,* Thomas Pond, Rattlesnake Pond or Crescent Lake, Hutchinson Pond, Moose Pond (P. 319), Highland Lake, Wood Pond, Long Pond* (P. 211), Moose Pond* (P. 179), and Coffee Pond. (The three indicated by an asterisk were the best.)

Fair plankton production: Panther Pond, Keoka Lake, Long Lake (P. 309), Kezar Lake, Moose Pond (P. 181), Trafton Pond, Burnt Meadow Pond, Adams Pond, and Bear Pond.

Poor plankton production: Stanley Pond, Barker Pond, Beaver Pond, Pleasant Lake, Peabody Pond,* Stearns Pond,* Crystal Lake or Anonymous Pond,* and Long Pond or McWain Pond.* (The four ponds indicated by an asterisk were the poorest.)

BOTTOM FOOD ORGANISMS OF FOUR LAKES

Bottom food organisms were collected by sampling with an Ekman dredge, which scooped up a sample 9 by 9 inches square, from four of the lakes and ponds which were surveyed. These included the two best salmon lakes, namely Sebago and Kezar, and two of the better trout ponds, namely Adams and Burnt Meadow.

Twenty samples were collected from Burnt Meadow Pond on July 15. These samples were from points scattered quite evenly over the entire area of the pond, in water 5 to 45 feet deep. The bottom was found to be almost entirely mud at all depths.

Seventeen samples were collected from Kezar Lake on July 19 to 20,—9 from Middle Bay, 8 from Upper bay—in water from 18 to 148 feet deep. The lake bottom at the points of these 17 samples was entirely mud. Seventeen additional attempts at sampling bottom organisms on the shallow shoals in Upper Bay were unsuccessful because of the presence of hard rubble or bedrock bottom.

Twenty-eight samples were collected from Sebago Lake on August 8—16 samples scattered over about 3 square miles of lake between Frye Island and the southwest shore of the lake, and 12 samples distributed over about 5 miles of shallows along the northwest shore. These samples

TABLE VI. Summary of results from 85 samples of bottom food organisms from four lakes of the area during 1938

Name of lake and data on samples			Volume in c.c. and number (in parentheses) of aquatic organisms in samples								
Depth range in feet	Type of bottom	Number of samples	Snails (Amnicolidae)	Mosquitoes (Corethra)	Midges (Chironomids)	Dragonflies (Anisoptera)	Mayflies (Ephemerida)	Alderflies (Sialidae)	Fresh-water shrimp (Amphipoda)	Aquatic earthwo (Chaetopoda)	All organisms
Burnt Meadow Pond (P. 195), July 15											
5–9	mud, sand	4	....	....	0.05 (4)	0.1 (3)	0.2 (4)	0.05 (1)	0.05 (14)	....	0.45 (26)
11–18	mud	5	....	0.05 (9)	0.05 (3)	0.2 (2)	0.3 (10)	0.1 (5)	0.01 (2)	....	0.71 (31)
21–28	mud	6	....	0.1 (33)	0.05 (13)	....	....	0.05 (1)	....	....	0.2 (47)
32–36	mud	3	....	0.07 (14)	0.1 (16)	....	....	....	....	....	0.17 (30)
43–45	mud	2	....	....	....	....	....	....	....	....	....
5–45 Total	....	20	....	0.22 (56)	0.25 (36)	0.3 (5)	0.5 (14)	0.2 (7)	0.06 (16)	....	1.53 (134)
Kezar Lake (P. 238), Middle Bay, July 19 to 20											
18–26	mud	9	....	....	0.029 (8)	....	0.304 (6)	0.16 (6)	0.06 (15)	0.007 (2)	0.56 (37)
Kezar Lake (P. 238), Upper Bay, July 19 to 20											
58–92	mud	4	....	0.003 (1)	0.097 (14)	....	....	....	....	....	0.1 (15)
110–148	mud	4	....	0.003 (1)	0.127 (14)	....	....	....	....	....	0.13 (15)
Sebago Lake (P. 291), August 8, southwest of Frye Island											
23–45	sand, clay, mud	6	....	....	0.01 (4)	....	....	....	....	....	0.01 (4)
55–120	sand, clay, mud	10	....	....	....	....	....	....	....	....	....
Sebago Lake (P. 291), August 8, along northwest shore											
13–32	sand, mud	4	0.03 (3)	....	0.002 (1)	....	....	....	....	....	0.032 (4)
55–86	sand, mud, clay	8	....	....	0.028 (10)	....	....	....	....	....	0.028 (10)
Adams Pond (P. 307), July 6											
6–9	mud, sand	5	....	....	0.01 (1)	0.3 (4)	0.1 (1)	....	0.02 (2)	....	0.43 (8)
12–18	mud	8	....	....	0.11 (5)	0.3 (4)	0.4 (11)	0.1 (3)	0.05 (2)	....	0.96 (25)
21–28	mud	3	....	....	....	....	0.1 (2)	....	....	....	0.1 (2)
33–36	mud	3	....	....	0.4 (16)	....	....	....	....	....	0.4 (16)
41	mud	1	....	....	....	....	....	....	....	....	....
6–41 Total	....	20	....	....	0.52 (22)	0.6 (8)	0.6 (14)	0.1 (3)	0.07 (4)	....	1.89 (51)

TABLE VII. The volumes and numbers of organisms in all samples and the calculated volumes and numbers per square foot of lake bottom for four lakes of the area (Summary of data given in Table VI.)

Lake	No. samples	Total organisms in samples		Organisms per square foot (calculated)	
		Vol. in c.c.	Number	Vol. in c.c.	Number
Burnt Meadow Pond	20	1.53	134	0.14	11.9
Kezar Lake	17	0.79	67	0.08	7.0
Sebago Lake	28	0.07	18	0.004	1.1
Adams Pond	20	1.89	51	0.17	4.5

were distributed fairly uniformly between depths of 13 and 120 feet. The bottom soil material as hauled up in the samples was approximately 75 per cent sand and 25 per cent clay and light mud; the bottom samples revealed little variation in soil types within this depth range of 13 to 120 feet.

Twenty bottom samples were collected from Adams Pond on July 6. These were from points scattered quite evenly over the entire area of the pond in water 6 to 41 feet deep. The bottom was found to be almost entirely mud.

The organisms encountered in these samples (see Tables VI and VII) were of the types which usually live in or on the bottoms of lakes. These included, in the approximate order of their relative importance by volume, Midge larvae, Dragonfly larvae, Mayfly larvae, Alderfly larvae, Fresh-water shrimp, Mosquito larvae, snails and aquatic earthworms. In general, there were many more midge larvae than any other single type of bottom organism, but the larger size of such forms as the Dragonfly, Mayfly and Alderfly larvae compensated somewhat for their small numbers.

Adams Pond was the richest in terms of volume of bottom organisms with 0.1 c.c. per square foot. Sebago Lake was by far the poorest in bottom food organisms with 0.004 c.c. per square foot. The two good trout ponds (Burnt Meadow and Adams) were much richer than the two good salmon lakes (Kezar and Sebago). All of the bottom food organisms in these lakes would not be available to trout or salmon during all months of the year because a large portion of the supply of bottom organisms was found to be in shallow and warm water which is not available to these cold-water fishes during the summer months. If these four lakes and ponds were to be given a food grade according to standards of abundance of bottom food organisms which have been set up by investigators working on lakes and ponds in other states, even the best of these four ponds would be graded as rather low. Adams and Burnt Meadow ponds and Kezar Lake are presumably far below average conditions in abundance of bottom food organisms and would be given a III food grade, if the food grade were based solely on bottom fauna. Sebago Lake is practically barren from the standpoint of bottom food organisms and this condition can be attributed for the most part to the fact that the bottom is almost entirely sand and clay. Sand and clay bottoms in a lake would not be expected to support any appreciable numbers of bottom organisms under any conditions.

FISH POPULATIONS OF THE LAKES

Source of information: Fishes were collected in almost all of the ponds which were surveyed, by the use of gill nets and seines. Two gill nets were used: one, 150 feet long by 12 feet deep, and the other, 475 feet long by 6 feet deep. Each of these two nets were fished in Sebago Lake for five over-night sets of about 18 to 24 hours each. Both of the nets were fished in Kezar Lake for three over-night sets, and for most of the other lakes and ponds they were fished for either two or one over-night set. Seining operations were carried on for about one or two hours in most of the lakes, and for a total of about four to six hours in several of the larger ones. This amount of collecting was believed to be sufficient to give a fairly accurate idea of the abundance of the various kinds of fishes which were present.

Fishes present: Nineteen species of fishes, representing 11 families, were taken by our collecting in ponds which were surveyed (see Table VIII). These included nine species of game and food fishes native to Maine:

Land-locked Salmon, *Salmo sebago*

Brook Trout, *Salvelinus f. fontinalis*

White Perch, *Morone americana*

Yellow Perch, *Perca flavescens*

Common Pickerel, *Esox niger*

Whitefish, *Coregonus clupeaformis*

Cusk, *Lota maculosa*

Smelt, *Osmerus mordax*

Horned Pout, *Ameiurus nebulosus*

two species of game fishes not native to Maine:

Chinook Salmon, *Oncorhynchus tshawytscha*
Small-mouthed Bass, *Micropterus dolomieu*

and eight other species of native Maine fishes:

Pumpkinseed Sunfish, *Lepomis gibbosus*
Creek Chub Sucker, *Erimyzon o. oblongus*
Common Sucker, *Catostomus c. commersonnii*
Fine-scaled Sucker, *Catostomus c. catostomus*
Fallfish, *Leucosomus corporalis*
Golden Shiner, *Notemigonus c. crysoleucas*
Bridled Shiner, *Notropis bifrenatus*
Common Shiner, *Notropis c. cornutus*

Estimates of the abundance of these species in the various ponds, as based on survey collections, are given in Table VIII. Other species of game and food fishes known to be present in some of these ponds are the native Togue *(Cristivomer n. namaycush)* and Common Eel *(Anguilla bostoniensis)*, and the introduced Brown Trout *(Salmo trutta)*.

Additional data on distribution and abundance of the fishes of these ponds were obtained from a questionaire submitted to each of the four Fish and Game Wardens who have direct supervision of these ponds (see Table IX). Each of these wardens are continually in contact with the local fishermen and they see the catches of fishes which are taken from these waters; also the wardens have the opportunity of seeing the spawning runs of many species. It is believed that the wardens are in a position to know the fish faunas of the various ponds very well, and therefore their estimates of the kinds and abundance of food and game fishes in these ponds is believed to be of considerable value in the present study.

Photographs[9] of some of these species of fresh-water fishes found in Maine are reproduced in Plates VII to XIV.

Competition between game species: It hardly seems necessary to present a great deal of the evidence which indicates that various kinds of food and game fishes compete with each other in many ways. Most evidence that warm-water game fishes compete and drive out trout and salmon is circumstantial, but nevertheless there is so much of this circumstantial evidence available that there is no doubt but what these two kinds of fishes do compete seriously with each other. First and probably of utmost importance is the fact that the food requirements of warm-water game fish, such as perch, bass, and pickerel, are very similar to those of trout and salmon. Also, over most of the eastern United States, perch, bass, and pickerel have been introduced into many of the ponds which originally supported no other game fishes except trout. The almost universal out-

[9]All photographs in this report are by M. T. Hilborn.

come of this introduction has been the disappearance of the trout. In a few instances such perch or other warm-water game fish populations have been removed, and it was then found that trout could be reestablished easily by stocking.

The distribution of game fishes in Maine is evidence of the effect of this competition. At one extreme there are in Maine many ponds with no warm-water game fishes at all, and these ponds when stocked with trout produce excellent fishing; at the other extreme there are many ponds which appear to be very similar in all respects except for an abundance of warm-water game fishes, and many of these ponds have been stocked heavily year after year but they continue to support very few trout (according to our collecting records) and very few trout are caught from them (according to reports by the wardens).

The density of the population of a given species of fish is a very important factor in determining the amount of competition which that species exerts against another. In other words, the greater the number of individuals of a competitive species, the more serious would be the competition. Likewise, it seems most logical to assume that competition against trout or salmon by two or more abundant species of warm-water fishes would be more severe than would be the case if there was only one competing species abundant.

Game fishes compete in at least the following ways:

1. Predation by the adults of one on the young of another
2. Direct competition for food
3. Competition for spawning areas
4. Actual competition for space

In measuring the amount of competition which would take place between the trouts and salmons on one hand and the warm-water game fishes such as the White Perch, Yellow Perch, Small-mouthed Bass, Pickerel, Cusk and Horned Pout on the other, it would be necessary to consider these various ways in which competition might take place.

Under natural conditions small trout and salmon usually live in streams until they are at least 5 or 6 inches long, and because of this fairly large size they are not subject to any great amount of predation by such warm-water game fishes as the White Perch and Yellow Perch. However, we have some evidence that large pickerel do eat salmon and trout even after they are large enough to live in lakes; undoubtedly large bass also eat them. Trout or salmon fry one or two inches in length, if planted in lakes, could be eaten by almost any of the game fishes.

Small trout and salmon feed mostly on insects and to some extent on small fishes. Large trout and salmon feed mostly on fish, the salmon mostly on smelt. The competition for food between the trouts and sal-

TABLE VIII. The kinds and abundance of game and food fishes in the ponds as estimated from survey collections

AB indicates species is abundant; C, species common; R, rare

Name and number of pond	Collecting gear used*	Land-locked Salmon *Salmo sebago*	Chinook Salmon *Oncorhynchus tshawytscha*	Brook Trout *Salvelinus f. fontinalis*	White Perch *Morone americana*	Yellow Perch *Perca flavescens*	Small-mouthed Bass *Micropterus dolomieu*	Common Pickerel *Esox niger*	Whitefish *Coregonus clupeaformis*	Cusk *Lota maculosa*	Smelt *Osmerus mordax*	Horned Pout *Ameiurus nebulosus*	Pumpkinseed Sunfish *Lepomis gibbosus*	Creek Chub Sucker *Erimyzon o. oblongus*	Common Sucker *Catostomus c. commersonnii*	Fine-scaled Sucker *Catostomus c. catostomus*	Fallfish *Leucosomus corporalis*	Golden Shiner *Notemigonus c. crysoleucas*	Bridled Shiner *Notropis bifrenatus*	Common Shiner *Notropis c. cornutus*
Stanley P. (P. 155)	S	.....	.....	.....	.....	R	.....	R	.....	.....	.....	.....	AB	R	.....	.....	C	.....	C	.....
Trafton P. (P. 156)	S	.....	.....	.....	.....	.....	.....	R	.....	.....	.....	.....	C	.....	.....	.....	.....	.....	AB	.....
Barker P. (P. 169)	S	.....	.....	.....	.....	R	R	R	.....	.....	.....	.....	R	.....	.....	.....	AB	R	R	R
Granger P. (P. 180)	S	.....	.....	.....	.....	.....	.....	R	.....	.....	.....	.....	R	.....	.....	.....	.....	.....	.....	.....
Moose P. Lower (P. 179)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Middle (P. 181)	G	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	R	.....	.....	.....	.....	.....
Upper (P. 182)	G	.....	.....	.....	AB	C	.....	R	.....	.....	.....	R	R	.....	C	.....	.....	C	.....	.....
Beaver P. (P. 183)	GS	.....	.....	.....	AB	R	.....	R	.....	.....	.....	.....	AB	.....	C	.....	R	.....	.....	.....
Burnt Meadow P. (P. 195)	GS	.....	.....	.....	.....	AB	.....	C	.....	.....	.....	.....	AB	.....	AB	.....	.....	.....	AB	.....
Long P. (P. 211)	G	.....	.....	.....	.....	R	.....	R	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kezar L. Lower Bay (P. 233)	S	.....	.....	.....	.....	C	.....	.....	.....	.....	.....	.....	AB	.....	.....	.....	C	R	.....	.....
Main Lake (P. 238)	G	C	.....	.....	C	.....	R	.....	.....	.....	C	.....	.....	.....	R	.....	R	.....	.....	.....
Sebago L. (P. 291)	GS	AB	.....	.....	AB	C	C	R	AB	AB	C	.....	R	.....	AB	R	AB	.....	R	AB
Peabody P. (P. 302)	GS	.....	.....	R	.....	R	.....	R	.....	.....	.....	.....	AB	.....	C	.....	C	.....	.....	.....
Trickey P. (P. 303)	GS	.....	.....	.....	.....	C	.....	R	.....	.....	.....	R	R	.....	.....	.....	.....	.....	.....	.....
Adams P. (P. 307)	GS	.....	.....	AB	R	.....	.....	R	.....	.....	.....	.....	AB	.....	.....	.....	.....	.....	.....	.....

Long L. (P. 309)	GS	.....	R	.....	AB	.....	C	R	.....	.....	.....	.....	.....	.....	C	.....	R	.....	.....	.....
Wood P. (P. 313)	GS	.....	.....	.....	R	.....	C	R	.....	.....	.....	.....	R	.....	C	.....	R	.....	.....	C
Highland L. (P. 314)	GS	.....	R	.....	C	.....	C	C	.....	.....	.....	.....	C	.....	C	.....	C	R	C	.....
Stearns P. (P. 315)	G	.....	.....	.....	R	R	.....	.....	.....	.....	.....	.....	.....	.....	R	.....	.....	.....	.....	.....
Moose P. (P. 319)	GS	.....	.....	.....	AB	.....	.....	R	.....	.....	.....	C	C	.....	R	.....	.....	.....	.....	.....
Bear P. (P. 321)	GS	.....	.....	.....	C	C	C	C	.....	.....	.....	C	R	.....	R	.....	AB	.....	R	.....
Keoka L. (P. 322)	GS	.....	.....	R	.....	.....	C	C	.....	.....	.....	.....	AB	.....	R	.....	.....	.....	.....	.....
Crystal L. or Anonymous P. (P. 324)	GS	.....	.....	.....	C	R	AB	C	.....	.....	.....	.....	R	.....	R	.....	.....	.....	.....	.....
Pleasant L. (P. 327)	GS	.....	.....	.....	AB	R	.....	.....	.....	.....	.....	.....	R	.....	AB	.....	.....	.....	.....	.....
Long P. or McWain P. (P. 332)	GS	.....	.....	.....	.....	C	C	R	.....	.....	.....	.....	C	.....	R	.....	.....	.....	.....	.....
Hutchinson P. (P. 337)	G	.....	.....	.....	.....	.....	.....	C	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Thomas P. (P. 356)	GS	.....	.....	.....	AB	.....	C	R	.....	.....	.....	C	C	.....	.....	.....	.....	.....	.....	.....
Panther P. (P. 357)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rattlesnake P. or Crescent L. (P. 359)	GS	.....	.....	.....	AB	R	C	C	.....	.....	.....	C	C	.....	.....	.....	AB	.....	.....	R
Coffee P. (P. 362)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

*Fishes were collected by gill nets (G) or Seines (S) or both (GS).

Ponds 155 to 238 inclusive are in the Upper Saco River drainage; ponds 302 to 362 drain through Sebago Lake and the Presumpscot River.

TABLE IX. The kinds and abundance of food and game fishes in the ponds as reported by the local State Fish and Game Wardens

These wardens reported the separate species as: abundant (AB), common (C), rare (R), or known to be absent (.). A ? indicates that the warden was not sure whether or not the species was present; a ? following an estimate of abundance indicates that the warden was doubtful concerning that estimate of abundance.

Name and number of pond	Reported by Warden*	Kind of fish: Land-locked Salmon	Chinook Salmon	Brook Trout	Togue (Lake Trout)	Brown Trout	Rainbow Trout	White Perch	Yellow Perch	Small-mouthed Bass	Common Pickerel	Whitefish	Cusk (Ling)	Smelt	Horned Pout	Common Eel	Sunfish	Sucker	Minnows (several species)
Stanley P. (P. 155)	B	R	.	.	.	?	.	.	C	.	R	.	.	R?	R	R	C	C	C
Trafton P. (P. 156)	B	R	.	R	.	?	.	.	C	.	R	.	.	?	C	R	C	C	C
Barker P. (P. 169)	B	.	.	R	.	.	.	.	C	R	C	.	.	.	C	R	C	C	C
Granger P. (P. 180)	B	.	.	R?	.	?	.	.	C	R?	C	.	.	?	C	R	C	C	C
Moose P. Lower (P. 179)	B	R	.	R?	.	.	.	C	C	R	C	.	.	.	C	C	C	C	R
Middle (P. 181)	B	R?	.	R	.	.	.	AB	AB	R	R	.	.	C	C	C	C	C	R
Upper (P. 182)	B	.	.	R	.	.	.	AB	AB	?	C	.	.	.	C	C	C	C	C
	F	R	.	R	.	.	.	AB	AB	?	AB	.	.	AB	C	C	AB	C	C
Beaver P. (P. 183)	B	.	.	R	.	.	.	R	AB	.	C	.	.	.	C	C	C	C	.
Burnt Meadow P. (P. 195)	B	R	.	R	.	.	.	.	C	.	R	.	.	R	C	R	C	R	C
Long P. (P. 211)	B	.	.	R	.	.	.	.	C	.	C	.	.	.	R	R	C	.	C
Kezar L. Lower Bay (P. 233)	B	R	.	.	.	.	.	C	AB	AB	AB	.	.	.	C	C	C	C	C
	F	C	.	R	.	.	.	AB	AB	AB	AB	.	.	.	C	C	C	AB	AB
Main Lake (P. 238)	B	C	.	R	.	.	.	C	AB	C	C	C	C	C	C	C	C	C	R
	F	AB	.	R	.	.	.	AB	AB	AB	AB	C	C	AB	C	C	C	AB	AB
Sebago L. (P. 291)	B	AB	R	R	.	.	.	R	R	C	R	AB	AB	C	R	R	R	C	R
	A	AB	.	C	.	.	.	C	C	AB	C	AB	AB	AB	C	C	C	AB	C
Peabody P. (P. 302)	B	R	.	C	.	.	.	.	R	?	C	.	.	C	C	C	R	C	R
Trickey P. (P. 303)	B	.	.	?	.	.	.	.	R	.	R	.	.	R?	?	?	R	?	R
Adams P. (P. 307)	B	.	.	C	.	.	.	C	C	C	C	.	.	.	C	C	C	?	R

Long L. (P. 309)	B	C	R	.	.	.	.	AB	C	C	C	.	C	C	C	C	C	C	C
	F	AB	R	R	.	.	.	AB	C	C	AB	.	AB	AB	AB	C	C	C	C
	W	C	R	.	.	.	.	AB	C	C	C	.	AB	AB	AB	C	C	C	C
Wood P. (P. 313)	B	.	.	.	.	?	.	C	C	C	C	.	.	.	R	C	C	C	R
Highland L. (P. 314)	B	R	?	R	.	.	.	C	C	C	C	.	.	R?	C	C	C	C	C
	F	R	C	R	.	?	.	AB	AB	AB	C	.	.	?	AB	C	AB	C	C
Stearns P. (P. 315)	B	.	.	R	.	.	.	R	C	C	C	.	.	R	C	C	C	C	R
	F	.	?	R	.	.	.	R	C	AB	C	.	.	C	C	C	C	C	C
Moose P. (P. 319)	B	R	.	.	.	.	.	AB	R	.	C	.	.	R	C	C	C	C	R
	F	R	.	.	.	.	.	AB	C	?	AB	.	.	?	C	C	C	?	R
Bear P. (P. 321)	B	C	.	R	.	.	.	R	C	AB	C	.	.	AB	C	C	C	C	C
	F	AB	.	R	.	.	.	R	AB	AB	C	.	.	AB	AB	C	C	C	C
Keoka L. (P. 322)	B	.	.	R	.	.	.	.	C	C	R	.	.	R	C	R	R	C	C
	W	.	.	C	.	.	.	.	C	C	C	.	.	C	C	C	C	C	C
Crystal L. or Anonymous P. (P. 324)	B	R	.	.	C	.	.	C	C	R	R	.	.	C	C	R	C	C	C
	W	R	.	.	C	.	.	AB	C	C	R	.	.	C	C	C	C	C	C
Pleasant L. (P. 327)	B	R?	.	R	?	.	.	C	R	?	R	.	.	R	C	R	C	C	C
	W	R	.	R	?	.	.	AB	C	?	C	.	.	C	C	C	?	C	C
Long Pond or McWain P. (P. 332)	B	.	.	?	.	.	.	?	C	R	C	.	.	C	C	R	C	C	C
	W	.	.	.	.	.	.	.	C	C	C	.	.	C	C	C	C	C	C
Hutchinson P. (P. 337)	B	.	.	C?	.	.	.	.	.	.	C	.	.	AB	AB	R	.	.	.
	F	.	.	AB	.	.	.	.	.	.	AB	.	.	AB	AB	.	.	?	.
Thomas P. (P. 356)	B	R	.	R	.	.	.	AB	C	C	C	.	R	.	C	C	C	C?	R
	A	R	.	C	.	.	.	AB	C	C	C	.	?	?	AB	C	C	AB	?
Panther P. (P. 357)	B	?	.	?	.	.	.	AB	C	R	R	.	C	C	C	R	C	C	C
	A	R	.	R	.	.	.	AB	R	C	C	.	C	AB	C	C	C	C	?
Rattlesnake P. or Crescent L. (P. 359)	B	.	.	R?	.	.	.	AB	C	C	R	.	.	C	C	C	C	C	C
	A	R	.	R	.	.	.	AB	R	C	C	.	?	AB	C	C	C	C	?
Coffee P. (P. 362)	B	R	.	?	.	.	?	.	C	.	R	.	.	C	C	R	C	?	R
	A	C	.	R	.	.	.	?	?	.	C	.	.	C	C	C	?	C	C

*Reports were made by the following wardens: (B) Chief Warden Verne M. Black, (A) Deputy Warden Delmore P. Adams, (F) Deputy Warden William R. French and (W) Deputy Warden James L. Walker.

mons versus all of the warm-water game species (particularly the bass, pickerel, and Cusk; to a considerable extent the perches; and to a lesser extent the Horned Pout) is mostly direct. During the summer when trout and salmon do most of their feeding they are down in fairly deep and cold water. The records of our gill net sets indicated that White Perch and Cusk in particular, and bass and pickerel to a lesser extent, all spend a considerable amount of time in this deep, cold water where their competition with the trouts and salmons would be most effective.

The warm-water game species in Maine do not compete with salmon and trout at all for spawning grounds since these two groups spawn at entirely different seasons of the year.

Competition for space or the existence of a space factor affecting fish distribution is almost entirely an unknown quantity, but there seems to be some circumstantial evidence that space, in itself, is important in competition. In other words, the mere presence of one species of game fish in a pond sometimes seems to make it impossible for a second species to become very well established, even though other conditions appear to be quite suitable for the second form.

A proposed competition factor: Not enough is known to completely define and evaluate the factor of game fish competition. However, it is well known that competition is of considerable importance, and an attempt has been made here to apply that knowledge to some practical advantage in trout and salmon stocking. In order to have some usable "yardstick" to express the amount of competition of warm-water game fishes against trout and salmon a competition factor in terms of a numerical figure has been employed.

The wardens' estimates on abundance of the various kinds of game fishes in these lakes and ponds are probably more reliable on the whole than the estimates on our own collecting, largely because of the fact that the time available for collecting was so limited. The estimates of abundance from the survey collections were used to supplement the estimates as given by the wardens. The estimates of abundance for warm-water game species in each lake were given a numerical value as follows: abundant (AB) = 3; common (C) = 2; rare (R) = 1. The following species were considered as being competitive with trout and salmon: White Perch, Yellow Perch, Small-mouthed Bass, Chain Pickerel, Horned Pout and Common Eel. A "competition factor" (CF) was obtained for each of the lakes and ponds by adding the abundance values for each of the above species present in each pond. For example, after combining the estimates of abundance of fish populations in the wardens' reports and our own estimates, it was concluded that Sebago Lake has White Perch (C-2), Yellow Perch (C-2), Small-mouthed Bass (C-2), Common Pickerel

(R-1), Cusk (AB-3), Horned Pout (R-1), and Common Eel (R-1). Thus the competition factor of warm-water game fishes against cold-water fish in Sebago Lake is expressed by a numerical value of 12. Competition factors for game fishes for all of the ponds which we surveyed were calculated in the same way (see Table XII).

Obviously the above method of getting a numerical figure to express competition is not a refined one. There are many possible weaknesses, of which the following might be mentioned: (1) the estimates of fish abundance are nothing more than a rough approximation of the number of individuals of any one species that are present, (2) the 3-2-1 ratio might be less applicable to the amount of competition than would be some other ratio, as for example a 5-3-1 ratio. If a species is abundant its competition might be more than 3 times as severe as it would be if the species were rare, (3) there is the fallacy of assuming that the different species of warm-water game fishes compete to the same extent, for example, that the competition by an abundant population of White Perch would be the same as of an abundant population of bass or pickerel. Possibly the Horned Pout is not a sufficiently serious competitor to be included in the list of competing species. There is also some doubt as to the validity of including the Eel in the list of competing species, although it is known that the Eel does feed on other fishes and thus must compete to some extent. The Eel occurred naturally in Maine in a great many ponds in which there were also abundant populations of native trout and salmon; possibly trout and salmon have been able to adjust themselves to some extent to an Eel population. It is also quite possible that the Smelt and Common Sucker should be included in the list of competitors. On the other hand, the extreme view might be taken of including all species of fish in the list of competitors.

In spite of these above possible fallacies, the proposed method of expressing the amount of competition against trout and salmon by warm-water game species is believed to be, in general, sound and of practical application.

The competition factors for the ponds and lakes which were surveyed revealed a fairly uniform amount of competition in a great many instances. Most of the larger ponds and lakes had a competition of from 10 to 15, or the equivalent of abundant populations of 3 to 5 species of warm-water game fishes which compete with trout and salmon. That this competition factor is fairly uniform is probably in part the result of the fact that these warm-water game fishes, themselves, compete with each other; in other words, a body of water can support only so many fish and if one or two species are very abundant they will then be competitive to keep the numbers of other species down. The larger ponds on the average have a greater competition factor than the smaller ones; this is due probably partly to the fact that more warm-water species have been introduced into the larger ones, and partly to the fact that, in smaller ponds, competition is more keen and these ponds can not support as great a variety of fish as the larger ones. The proposed application of the competition factors to stocking recommendations is considered in the following section of this report.

STOCKING POLICY FOR TROUT AND SALMON AND FOR BASS, AND STOCKING RECOMMENDATIONS FOR THE LAKES AND PONDS WHICH WERE SURVEYED

The ideal of the development of a stocking policy is to be able to calculate the number of individuals, and their size, of a desirable game species which when planted in a given body of water will give the best possible fishing to the angler for the least cost to the fish cultural enterprize. No well-informed fish culturist would claim that this acme of perfection has been reached in the management of any fish species. Conservation agencies throughout the country have been, and are, conducting various types of scientific surveys on lakes and streams in an attempt to determine what kinds of fishes, and how many, should be stocked in each body of water. It is expected that the results of the present survey will aid the Maine State Hatchery System in making its fish-planting program still more effective than it is at present.

Trout and Salmon. Some of the more important factors in the biology of a lake which determine its suitability for various species of game fishes (particularly trout and salmon) were studied during the present survey, and these are the factors which have been used as a basis for stocking recommendations, namely:

1. Size and depth of lake and the amount of water
2. Temperature at various depths
3. Oxygen and pH contents at various depths
4. Basic fertility, as indicated by the abundance of plankton
5. Abundance of bottom food organisms
6. Kinds and abundance of fishes present

The size of a lake is important in determining its carrying capacity. Depth is important in determining the amount of deep, cold water which is present during the summer. Temperature and oxygen together are directly important in determining where trout and salmon can live during the summer. In the present study 70° F. has been set as the upper limit for trout water. It might be argued at this point that this temperature limit should be at 75° F. rather than 70° F., but our lake collecting definitely indicates that trout and salmon remain in water much below

70° F. during the summer. Also, our 1937 survey of streams in York and Cumberland counties[10] indicated that trout prefer water much below 70° F. Setting the upper temperature limit at 70° F. rather than 75° F., for the lakes studied during 1938, is probably also desirable from an entirely different standpoint. During the summer of 1938, there was unprecedented rainfall in this section of the state during the month of July and lake conditions presumably were not as critical for trout in these lakes, from the standpoint of temperature, as they would be during some very dry and hot summer, at which time 75° F. water would probably be driven down as deep as was 70° F. water in 1938. The temperature point of 70° F. is used, therefore, in designating the limits of good trout water in the lakes considered in this report.

With the data on lake and pond areas, depth, temperature, and oxygen, the amount of water suitable for trout and salmon and the amount of water not suitable for trout and salmon in these lakes during the critical summer stagnation period was calculated. Likewise the amount of bottom area on which trout and salmon could feed during this period was determined. These factors are of utmost importance in determining whether or not any particular lake or pond can support any appreciable numbers of trout, salmon, or any other predominantly cold-water fish. Stocking trout and salmon in lakes in which there is absolutely no trout or salmon water during the summer would be expected to give exceedingly poor results, if any at all. Furthermore, the ability of a lake to support any great numbers of trout must be roughly in proportion to the amount of trout water present, if food conditions were somewhat similar. Conditions in lakes vary continually from the spring turnover stage to the fall turnover stage and more of the area of a pond or lake is available to trout and salmon during the spring and fall than during the summer. Thus, there might be a considerable error involved if the carrying capacity of the lake for trout or salmon were calculated on the basis of only late summer conditions, or on only spring or fall conditions. Trout and salmon feed and grow mostly, if not entirely, during the spring, summer and fall months; and, presumably, a considerable part of their growth is made during the summer. Therefore, the carrying capacity of a lake for trout or salmon would be determined by the average of conditions over the entire period covering spring, summer and fall, provided that conditions during the most critical period were still very favorable.

The abundance of plankton organisms—particularly water fleas—is a fairly reliable index of the fish producing capacity of a lake; this is particularly true for lakes where bottom food organisms are rare, as in

[10]Cooper, Gerald P.: 1939. A biological survey of the waters of York County and the southern part of Cumberland County, Maine. Maine Dept. of Inland Fish. and Game Fish Survey Report No. 1.

some, if not all, of the lakes studied by the present survey. These free-floating microscopic animals and plants are the chief food of most small fishes, as for instance the young of smelt, perch, bass, and minnows. Plankton forms also make up an important part of the food of the adults of some fishes, such as the Whitefish. These plankton organisms are of importance to trout and salmon largely through the smelt food chain and to some extent the food chain involving minnows and young perch. The abundance of bottom insects is of more importance to trout in small ponds than to salmon in large lakes. In many ponds the aquatic insects living on the bottom are the chief food of trout during a large part of the summer when the trout live in the deep water and do not get to the surface for terrestrial insects.

The kinds and abundance of fishes are important in at least two ways: the abundance of smelt, minnows and other small fishes is important as food for salmon and large trout; and the abundance of warm-water game fishes is important since these species are both competitors of, and to some extent predators on trout and salmon.

In a recent paper on stream and lake surveys, Davis[11] (1938:30) presented a "Planting Table for Trout Lakes" in which are proposed the numbers of three-inch trout to be planted per acre in lakes with good and poor spawning facilities, with various degrees of richness in food organisms, and with various degrees of fishing intensity (see Table X).

TABLE X. Planting table for trout lakes; number of 3-inch trout per acre (as proposed by Davis: 1938)

Fishing Intensity	Grade I — Food abundant		Grade II — Food average		Grade III —Food rare	
	Good spawning	Poor spawning	Good spawning	Poor spawning	Good spawning	Poor spawning
Heavy	180	240	90	120	50	60
Medium	90	180	45	90	25	45
Light	30	120	15	60	10	30

These figures, as proposed by Davis, for stocking trout lakes probably should not be applied without some flexibility to all lakes in the country or to all lakes in a given locality, and undoubtedly this author did not believe that they should be.

[11]Davis, H. S.: 1938. Instructions for conducting stream and lake surveys. U. S. Bur. Fish., Fishery Circular No. 26.

In addition to the factors of food supply, spawning facilities, and fishing intensity as considered by Davis, there is one very important factor that should be considered in formulating a stocking policy for trout lakes, namely, the abundance of competing warm-water game species. In some lakes in Maine the presence of warm-water game species appears to be a very severe limiting factor to trout populations, as stocking in what appears to be excellent trout lakes produces almost nothing when warm-water game fishes are abundant. A modified form of Davis' stocking table is proposed here (see Table XI) for those lakes of southern Maine which

TABLE XI. A proposed planting table (highly theoretical) for trout and salmon in lakes of southern Maine; number of 6-inch* fish per acre**

Fishing intensity	CF: Competition by warm-water game fishes	Grade I — Food abundant		Grade II — Food average		Grade III — Food rare	
		Good spawning	Poor spawning	Good spawning	Poor spawning	Good spawning	Poor spawning
Heavy	0	100	130	50	65	25	35
	3	75	100	35	50	20	30
	6	50	65	25	35	15	25
	9	35	45	20	25	12	20
	12	25	30	15	20	10	15
Medium	0	50	100	25	50	15	25
	3	35	75	20	35	12	20
	6	25	50	15	25	10	15
	9	20	35	12	20	9	12
	12	15	25	10	15	8	10
Light	0	15	65	10	35	10	15
	3	12	50	9	30	9	12
	6	10	35	8	25	8	10
	9	9	25	6	20	6	9
	12	8	20	5	15	5	8

*Figures are given here for 6-inch rather than 3-inch fish because it is believed to be highly desirable to stock these larger fish. Brook Trout and Land-locked Salmon under natural conditions usually do not leave the stream habitat and enter lakes until they are at least about six inches long.

**Not based on the total area of the lake, but on the average between the total area and the area of bottom available to trout and salmon during late summer (see text).

were surveyed during 1938. This stocking table, applicable to both trout and salmon, has been formulated as follows:

Lakes are considered suitable, from the standpoint of water supply, for stocking with trout and salmon if the per cent of the volume of water, and the per cent of the area of the bottom, which are accessible to trout and salmon during the late summer average at least about 15 per cent of the total. If this amount of suitable trout water is available during late summer, then the amount of stocking recommended is in proportion to the average between (a) the amount of bottom area available to trout and salmon during late summer, and (b) the total bottom area of the lake. Stocking on the basis of the amount of bottom area available to trout during late summer is actually also stocking on the basis of the amount of trout water present, for in most lakes the per cent of the water volume, and the per cent of the bottom area, available to trout during late summer, are about the same. Stocking according to this average area is based on the facts that, at the beginning of a growing season in early spring, trout and salmon can live in almost all parts of any given lake, and that, during late summer, trout and salmon are confined to a much more limited area and volume of water. The amount of bottom area and water volume available to trout and salmon on the average for the entire growing season presumably would be about the average of conditions at the two extremes.

Lakes are classified on the basis of food for: (a) trout, on the abundance of plankton organisms and bottom insects and to a lesser extent on the abundance of smelt and other forage fishes, and (b) salmon and togue, mostly on the abundance of smelt and plankton and to a minor extent on the abundance of other small fishes. Lakes are graded with respect to food as follows: I—Food abundant, II—Food average, and III—Food rare.

Lakes are classified according to fishing intensity as heavy, medium, and light. About twice as many fish are to be stocked in heavily fished lakes as in lakes with medium fishing intensity, and the latter are to be stocked about twice as heavily as lightly fished lakes.

Allowance in the stocking recommendations is made for the suitability of tributary streams for trout and salmon spawning. Lakes with poor spawning streams are to be stocked about twice as heavily as lakes with good spawning tributaries. This is based on the assumption that natural spawning will furnish part of the supply of small fish for the lake.

Lakes are classified according to the amount of competition (expressed as a numerical value—CF, see the preceding section of this report) by warm-water game species such as perch, bass and pickerel. It is assumed that the presence of one competing species of warm-water game fish would cut down the carrying capacity of a pond for trout and salmon, and that two species would cut down this carrying capacity more than would one. Undoubtedly six abundant species would cut it down more than would two. For each equivalent of two abundant species (CF = 6) it is assumed that the carrying capacity would be about half the carrying capacity if no warm-water game species were present at all. If there were four species of warm-water game fishes present (CF = 12) it is assumed that the carrying capacity would be only one-fourth the theoretical amount. This method of modifying a theoretical stocking policy according to the abundance of competing warm-water game fishes is considerably theoretical. A more refined method would necessitate a great deal of knowledge concerning the abundance of game fish populations in lakes and the manner and extent to which the abundance of one species affects that of another; at present this information is not available.

The figures for stocking lakes with trout as given by Davis have been used as the basis for the present proposed stocking table (Table XI), with two modifications: (1) the figures have been calculated on the basis of six-inch trout or salmon, since it is believed to be highly desirable to stock fish at least six inches long in lakes, and (2) additional figures are given for lakes with varying degrees of warm-water game fish competition.

The kinds and numbers of trout and salmon recommended for yearly stocking in the lakes and ponds of southern Maine which were studied during the present survey are given in Table XII. In this table are given also the food grade, suitability of tributary streams for trout and salmon spawning, warm-water game fish competition factor, fishing intensity, and the average area supporting trout or salmon, for each of the 31 lakes and ponds. The total numbers of trout and salmon recommended for yearly stocking for this group of lakes as a whole are as follows:

200,000 six-inch Land-locked Salmon for Sebago Lake
34,900 six-inch Land-locked Salmon for four other lakes
24,750 six-inch Brook Trout for nine lakes
30,800 six-inch Chinook Salmon for Long Lake
14,000 two-inch Togue (Lake Trout) for Crystal Lake

This same group of 31 lakes and ponds received an average yearly stocking by the Maine Department of Inland Fisheries and Game during the five-year period from July 1, 1933 to June 30, 1938 of the following:

Sebago Lake

40,000 two- to four-inch Land-locked Salmon
35,000 four- to six-inch Land-locked Salmon
17,000 "mature" (over six inches) Land-locked Salmon
12,000 four- to six-inch Brook Trout
80 "mature" Brook Trout
2,000 four-year-old Brook Trout

TABLE XII. Summary of the development of a stocking policy* and the yearly stocking recommendations for 6-inch trout or salmon and 3-inch fingerling Small-mouthed Bass for the lakes and ponds which were surveyed

Information on "Spawning streams for trout and salmon" and "Fishing intensity" obtained from Chief Warden Verne M. Black

Name and number of pond	Township or county	Food grade	Spawning streams for trout & salmon	Game fish competition factor: CF	Fishing intensity	Area supporting trout or salmon: acres	Yearly stocking recommendations: 6-inch trout or salmon; or 3-inch Small-mouthed Bass
Stanley P. (P. 155)	Hiram, Porter	III	Poor	5	Light	97	1,800 Brook Trout
Trafton P. (P. 156)	Hiram, Porter	III	Poor	6	Light	33 (small per cent)	350 Brook Trout
Barker P. (P. 169)	Hiram	II	Poor	8	Light	None	No trout or salmon. Stock 800 Small-mouthed Bass fingerlings
Granger P. (P. 180)	Denmark	?	None	8	Light	Small	No trout or salmon. Stock 50 adult Small-mouthed Bass first year; and 500 fingerling Small-mouth Bass yearly
Moose P. Lower (P. 179)	Oxford Co.	II	Poor	11	Medium	None	No trout or salmon. No stocking of warm-water game fish
Middle (P. 181)	Oxford and Cumberland Co.	II for salmon	Poor	12	Medium	746	11,300 Land-locked Salmon
Upper (P. 182)	Oxford and Cumberland Co.	II	None	12	Medium	None	No trout or salmon. No stocking of warm-water game fish

Beaver P. (P. 183)	Bridgton	III	None	10	Light	None	No trout or salmon. Stock 300 Small-mouthed Bass fingerlings and 1,000 White Perch fingerlings
Burnt Meadow P. (P. 195)	Brownfield	III for trout	Fair	7	Medium	44	700 Brook Trout
Long P. (P. 211)	Denmark	II	None	6	Light	None	No trout or salmon. Stock 50 adult Small-mouthed Bass
Kezar L. Lower Bay (P. 233)	Lovell	II	Good	15	Medium	None	No stocking of warm-water game fishes
Middle and Upper Bays (P. 238)	Lovell	II for salmon	Good	15	Heavy	1,396	16,700 Land-locked Salmon
Sebago L. (P. 291)	Cumberland Co.	I for salmon	Good	12	Heavy	25,779	200,000 Land-locked Salmon. No stocking of warm-water game fish.
Peabody P. (P. 302)	Bridgton, Naples, Sebago	III for salmon	Poor	7	Medium	652	4,500 Brook Trout. 4,600 Land-locked Salmon. No stocking of warm-water game fish
Trickey P. (P. 303)	Naples	?	None	4	Light	187	5,200 Brook Trout
Adams P. (P. 307)	Bridgton	II for trout	Fair	10	Medium	73	1,500 Brook Trout.
Long L. (P. 309)	Cumberland Co.	II for salmon	Fair	15	Heavy	3,811	30,800 Chinook Salmon (if available), otherwise Land-locked Salmon.

*For explanation of "Food grade," "Game fish competition factor: CF", and "Area supporting trout or salmon: acres," see text.

TABLE XII. **Development of stocking policy and yearly stocking recommendations (concluded)**

Name and number of pond	Township or county	Food grade	Spawning streams for trout & salmon	Game fish competition factor: CF	Fishing intensity	Area supporting trout or salmon: acres	Yearly stocking recommendations: 6-inch trout or salmon; or 3-inch Small-mouthed Bass
Wood P. (P. 313)	Bridgton	II	Poor	10	Light	None	No trout or salmon. Stock 1,700 Small-mouthed Bass fingerlings.
Highland L. (P. 314)	Bridgton	II	Fair	11	Medium	None	No trout or salmon of any kind. Stock 11,000 Small-mouthed Bass fingerlings.
Stearns P. (P. 315)	Sweden	III	Fair	11	Light	Small per cent	No trout or salmon. Stock 500 Small-mouthed Bass fingerlings.
Moose P. (P. 319)	Waterford	II	Fair	10	Light	Small per cent	No trout or salmon. Stock 700 Small-mouthed Bass fingerlings.
Bear P. (P. 321)	Waterford	II for salmon	Fair	12	Light	152	2,300 Land-locked Salmon.
Keoka L. (P. 322)	Waterford	II for trout	Fair	9	Medium	263 (small per cent)	1,500 Brook Trout.
Crystal L. or Anonymous P. (P. 324)	Harrison	III for trout	Poor	12	Light	355	14,000 two-inch Togue (Lake Trout).
Pleasant L. (P. 327)	Otisfield, Casco	III	Fair	7	Light	676	6,700 Brook Trout.

Long P. or McWain P. (P. 332)	Waterford	III	Fair	10	Light	265 (small per cent)	No trout or salmon. Stock 1,900 Small-mouthed Bass fingerlings.
Hutchinson P. (P. 337)	Albany	II	None	6	Light	None	No trout or salmon. Stock 50 adult Small-mouthed Bass first year; and 750 Small-mouthed Bass fingerlings yearly.
Thomas P. (P. 356)	Casco–Raymond	III	Fair	13	Medium	None	No trout or salmon. Stock 3,500 Small-mouthed Bass fingerlings.
Panther P. (P. 357)	Raymond	III	Fair	12	Light	795 (small per cent)	No trout or salmon. Stock 4,200 Small-mouthed Bass fingerlings.
Rattlesnake P. or Crescent L. (P. 359)	Raymond, Casco	III	Fair	12	Medium	None	No trout or salmon. Stock 6,500 Small-mouthed Bass fingerlings.
Coffee P. (P. 362)	Casco	II for trout	None	6	Light	104	2,500 Brook Trout.

All other lakes

4,000 Land-locked Salmon fry
7,200 two- to four-inch Land-locked Salmon
27,600 four- to six-inch Land-locked Salmon
3,300 "mature" Land-locked Salmon
21,200 four- to six-inch Brook Trout
7,900 "mature" Brook Trout
5,000 "mature" Brown Trout
8,900 four- to six-inch Chinook Salmon
6,000 "mature" Chinook Salmon
2,000 Togue (Lake Trout) fry
1,600 four- to six-inch Togue

The figures on the number of trout and salmon recommended by the writer for these 31 lakes are for six-inch fish. In determining how closely the average stocking of fish into these lakes during the past five years approaches the recommended yearly stocking, this difference in size should be considered. One hundred four- to six-inch fish are equivalent, in terms of expected survival to the adult stage, to about 80 six-inch fish; and 100 two- to four-inch fish are equivalent to about 60 six-inch fish. On the basis of these conversion factors, the average annual stocking of salmon and trout in Sebago Lake over the past five years has been equivalent to approximately 81,000 six-inch salmon; the average annual stockings for the other lakes have been equivalent to 30,000 six-inch Land-locked Salmon, 25,000 six-inch Brook Trout, 5,000 six-inch Brown Trout, 13,000 six-inch Chinook Salmon, and about 3,000 two-inch Togue fry. In order to fulfill the yearly stocking quotas recommended in this report it will be necessary either for the hatcheries to increase their output, particularly to meet the greater supply of salmon for Sebago Lake, or to transfer to these lakes fish which would otherwise be planted in other waters. To make up the deficiency by increasing the hatchery output would require a 150 per cent increase in salmon for Sebago Lake, a 15 per cent increase in salmon for other lakes, no change in output of Brook Trout, a 100 per cent increase in Chinook Salmon, and an increase to 14,000 of Togue output.

The present stocking recommendations introduce several important changes in distribution of trout and salmon among the various lakes and ponds. Five ponds, which have been stocked heavily with trout or salmon during the past five years, were found to be unsuitable for these fishes; these ponds are Wood Pond, Highland Lake, Hutchinson Pond, Thomas Pond, and Rattlesnake Pond or Crescent Lake. A considerable increase in amount of stocking is recommended for some ponds, and a considerable decrease for others.

Details on past stocking records and on the present recommendations are given in a later section of this report on a summary of survey results and recommendations for each lake.

Several suggestions concerning the propagation and distribution of trout and salmon for Maine lakes are offered in the interest of making the stocking program more effective:

1. Raise all trout and salmon (except Togue) to at least six inches in length before planting them in lakes. Small trout and salmon are not adapted to open foraging in lakes. Also, smaller trout and salmon are more readily preyed upon by bass, pickerel and perch which are abundant in many lakes of southern Maine.
2. Distribute fish stocking in a given lake uniformly from year to year.
3. Stock trout and salmon in lakes either during early spring or late fall, not during the hot summer months of July and August. If it is presumed that transferring trout from a stream to a lake is a drastic change and requires considerable adjustment on the part of the fish, then the change would be most drastic during July and August when the upper water of the lake is too warm and conditions generally in the lake are most critical for cold-water fishes.
4. Stock no warm-water game fishes, such as bass, pickerel or perch in lakes which are being stocked with trout or salmon.

SMALL-MOUTHED BASS. The Small-mouthed Black Bass *(Micropterus dolomieu)*, since its introduction into Maine about eighty years ago, has become widespread in its distribution over the southern half of the state. It is now perhaps the most important of the warm-water game fishes to the Maine angler. The State Fish and Game Department has only recently established bass rearing ponds and this venture is still on a very small scale.

The results of the present survey indicate that many lakes should be developed chiefly for bass fishing, and our seining operations revealed that young bass were generally very rare in reportedly good bass lakes. The stocking of Small-mouthed Bass in 13 of the 31 lakes is therefore recommended (see Table XII); these 13 lakes are: Barker Pond, Granger Pond, Beaver Pond, Long Pond (P. 211), Wood Pond, Highland Lake, Stearns Pond, Moose Pond (P. 319), Long or McWain Pond, Hutchinson Pond, Thomas Pond, Panther Pond, and Rattlesnake Pond or Crescent Lake. The total number of three-inch fingerling bass recommended for yearly stocking is 32,350; an additional 150 adult bass are recommended as a brood stock for three ponds.

Fingerling bass were recommended on the basis of size of the lake, intensity of fishing, abundance of food, and spawning facilities offered by the lake. A stocking table for three-inch bass (see Table XIII) has been developed to partially meet the requirements of these lakes of southern

TABLE XIII. A proposed stocking table for Small-mouthed Bass for bass lakes of southern Maine; number of 3-inch fingerlings per acre

Fishing Intensity	Grade I — Food abundant		Grade II — Food average		Grade III — Food rare	
	Good spawning	Poor spawning	Good spawning	Poor spawning	Good spawning	Poor spawning
Heavy	18	24	12	16	6	8
Medium	12	18	8	12	4	6
Light	6	12	4	8	2	4

Maine. The figures given in this table represent comparatively light stocking; but stocking on the basis of these figures should considerably increase the bass population, judging from the present scarcity of young bass as indicated by our seinings.

Bass hatchery ponds to produce the 32,350 three-inch fingerlings yearly probably can be developed to best advantage in the extreme southern part of Maine where the climate is warmer and the growing season longer. A production of approximately 5,000 three-inch fingerlings per acre can be expected with normal success of intensive propagation in small ponds. A total of about 6 acres of bass rearing ponds would thus be required to produce the bass recommended for these 13 lakes.

In stocking the fingerling bass, they should be distributed quite evenly in shallow water completely around the margin of the lake; such stocking could be done most effectively from a boat. Adult breeding bass for planting in the three ponds and for bass hatcheries should be obtained from a locality where the bass are free from the bass tapeworm *(Proteocephalus ambloplitis)*. More harm than good can be done if infected fish carry this parasite to waters where it does not occur. So far as known, the bass tapeworm can be spread from one locality to another only by infected bass or other fish or infected fish food organisms.

The Large-mouthed Black Bass *(Aplites salmoides)* is not recommended for any of the bass lakes for two reasons: (1) these lakes are not adapted at all to the largemouth, and (2) the advisability of widely distributing a second species of bass in Maine waters is very questionable.

OTHER FISH MANAGEMENT POLICIES FOR THE LAKES AND PONDS WHICH WERE SURVEYED

In the present field of fisheries management it is being recognized more and more that stocking fishes, by itself, can not always maintain an abundant population of any desirable species. Fish conservationists everywhere are recognizing the fact that stocking must be accompanied by a management program applied to the natural waters themselves. Two methods which are very essential to effective management are (1) the control of fish populations in natural waters, and (2) restrictions on the fish taken by the angler. Most sportsmen are reconciled to the necessity of restrictions, but few will accept the more drastic measures of fish population control which are equally as essential.

CONTROL OF WARM-WATER GAME FISHES IN TROUT AND SALMON LAKES
The necessity of the control of fish populations can be explained most readily by the much-used analogy of comparing pisciculture with agriculture. The basic principles involved are identical. The different species of plants are competitive for space and food. The presence of one type limits the presence of another to some extent. Competition is most keen between individuals of the same type, and a very dense population of one type usually operates to the disadvantage of each individual of that population. The control measures employed by the agriculturist are simple and effective. The farmer weeds his garden so that the desirable crops will not have to compete with the weeds. The gardener thins his onions to give the remaining individuals more room to grow. The same basic principles of competition are involved amongst fish populations, and similar methods of control can and should be employed.

The rise in abundance of warm-water game fishes in many lakes and ponds in the southern part of Maine has been coincident with a decrease in the salmon and trout populations. There are, however, in the central and northern part of the state a great many shallow ponds in which trout maintain a great abundance even in spite of intensive fishing. These contrasting situations constitute almost conclusive circumstantial evidence to the effect that Yellow Perch, White Perch, Small-mouthed Bass and Common Pickerel drive trout and salmon out of lakes, either by predation or competition or in some other way. In brief, these warm-water fishes exist in lakes and ponds largely at the expense of trout and salmon; therefore it is absolutely necessary that in the state's broad program of maintaining and improving populations of trout and salmon, the abundance of these warm-water species be considered.

Perhaps most of the more ardent fishermen in Maine are primarily interested in catching trout and salmon, but there is also a large proportion of fishermen in this state, particularly summer tourists, who spend much of their time in Maine during July and August when trout and salmon fishing is usually the poorest, and these fishermen fish for and catch mostly perch, bass and pickerel. Also winter fishing for pickerel is very important to many of our own residents. Any fair program of improvement of our waters for fishing should include the interests of these various groups; also any scientific program of improvement should take into account the peculiarities of each separate body of water and the type of fishes which that body of water will support best. Of the 31 lakes and ponds which were studied during the present survey, about one-half of them have water which is very good to fair in its capacity to support trout and salmon, and the other half have very little or no trout water and should therefore be managed for warm-water game fishes. This natural division of these 31 ponds into about half trout and half non-trout water offers the opportunity of maintaining and developing both trout and salmon fishing for the ardent angler and warm-water game fishing for the not-so-ardent but just as important mid-summer tourist.

In order to keep this balance of half trout waters on the one hand and half warm-water game fish waters on the other, much more effort must be given to favor the trouts and salmons for the very obvious reason that they themselves tend to be driven out by the warm-water species. The necessity of aiding the cold-water species is evident in the fact that practically all of the state fish propagation efforts are concentrated on the trouts and salmons. In view of this considerable expenditure for the propagation of trouts and salmons, it is certainly good business to do whatever is possible to favor the survival of these propagated fish after they are stocked in natural waters. It is therefore absolutely necessary to plant these fish in lakes or streams where the water itself is suitable; and it is also highly desirable to control as much as possible the warm-water game fishes which are present in these trout and salmon lakes and which would eat the planted trout or drive them out by competition for food or space. Fishermen should be conscious of the fact by now that you can not have a great many different species in any one lake or pond and expect to have good fishing for all of them. It is by far the best policy to try to keep trout and salmon lakes just for these fish and not introduce any of the warm-water species if good trout and salmon fishing is desired in the future. The present status of the game fish populations in many of the lakes in southern Maine can not be regarded with too much optimism, for many of these lakes have good water and should be excellent trout and salmon lakes, but are not because of the present abundance of the warm-water species. There are others, however, which still produce fair trout fishing even though warm-water game fishes are fairly abundant. It is quite probable that trout fishing in most of these ponds in the southern part of the state may continue to decrease in the future if the present warm-water game species increase in abundance, or if other warm-water species are introduced. Undoubtedly a great many of these ponds in the southern part of the state would produce more trout and salmon fishing if the perch, bass and pickerel were not present.

Certain measures of fisheries management on these trout lakes in the southern part of Maine seem both easy and practical, and certainly would result in better survival of stocked and naturally spawned trout and salmon, and thus result in better fishing. The following methods of controlling warm-water game fishes are recommended for all of the lakes and ponds which were found in the present survey to have excellent to good trout water and for which trout or salmon stocking is here recommended. The lakes are as follows: Stanley Pond, Trafton Pond, Moose Pond (P. 181), Burnt Meadow Pond, Kezar Lake, Sebago Lake, Peabody Pond, Trickey Pond, Adams Pond, Long Lake (P. 309), Bear Pond, Keoka Lake, Crystal Lake or Anonymous Pond, Pleasant Lake, and Coffee Pond. The recommendations are as follows:

1. Remove all legal restrictions on warm-water game species, especially White Perch, Yellow Perch, Small-mouthed Bass and Pickerel; allow fishermen to take these fish at all seasons of the year and to take them at any size; and encourage fishermen to take as many as possible in order to deplete their numbers.
2. Do not stock bass, perch, pickerel or any other kind of warm-water game fish in lakes or ponds which are stocked with trout or salmon.
3. For very good trout or salmon lakes where White Perch are very abundant, the State Fish and Game Department should have a regular program of seining out young perch when they are congregated in shallow water during the summer.
4. Destruction of perch and pickerel on their spawning grounds whenever possible.
5. Prohibit by law fishing for smelts in the lakes or taking smelts in any way from the stream spawning runs for all lakes in which salmon, trout or togue are stocked, with the possible exception of Sebago Lake. In the case of Sebago Lake, the present smelt-runs up most of the tributary streams, particularly the Songo River, are enormous. However, some of the local game wardens expressed the belief that the size of the runs has decreased somewhat in recent years. There is absolutely no reason to believe that the supply of smelts in Sebago Lake is inexhaustible. Man has unfortunately made that assumption in the case of the Whitefish and Cisco in the Great Lakes, in the case of several commercial species of marine fishes, and in the case of the passenger pigeon and many others. The Smelt is the chief food of the salmon and most other

food and game fishes in Sebago Lake; and this is of particular importance because the bottom food organisms in that lake are extremely rare and small smelts are about the only type of food which is available to the adults of game fishes. It does not seem desirable to recommend complete protection of the Smelt in Sebago Lake at the present time. If, however, the Smelt population in Sebago ever decreases greatly, the Smelt should be given complete protection. If the Smelt population of Sebago is ever completely wiped out, it is a safe prediction that the salmon fishing will be completely gone.

6. For some lakes and ponds which have very good trout waters but no trout fishing because of the abundance of perch, bass or pickerel, the best procedure would undoubtedly be to poison the pond completely to remove all of the fish and then start over again by planting trout. The Fish and Game Department will decide all instances where ponds should be poisoned and will supervise all such poisoning operations.

Restrictions on Bass Fishing. The fact that laws regulating open seasons and size and bag limits on game fishes have been forced upon the fishing public for the past 1,000 years or more might be cited as evidence that the conservationists have long recognized the necessity of such restrictions. Long years of experience have revealed that practically no species of fish in almost any type of habitat can maintain any great abundance if the fishing public concentrate their efforts on that species without any restrictions as to season, size or bag limit. Throughout the course of the present survey it was more and more apparent that certain additional restrictions on fishing here in Maine might prove in the long run to be very desirable and decidedly to the advantage of the fishermen themselves. The writer wishes to point out at this time that the following restrictions are suggested entirely with the belief that eventually they will produce better fishing. It might also be pointed out at this time that Maine fishermen are not confronted with as drastic restrictions as are the fishermen of many of the other states in the northeastern part of the country.

Small-mouthed Bass occur in 19 of the 31 lakes and ponds which were surveyed, according to our own collecting records and the reports of the local Fish and Game Wardens. During our present survey, the shallow waters of 14 of these 19 lakes containing bass were seined for a total of 26¾ hours with nets mostly over 20 feet long. Only 199 bass (mostly fry) were taken from these 14 lakes during this seining, or an average of approximately 7 bass per hour of seining effort. This, to the writer, indicates an exceedingly small population of small bass and thus very poor returns from natural spawning, even though most of these 14 lakes have excellent spawning grounds for this species.

The Small-mouthed Bass prepares a cup-like nest in the gravel bottom and its adhesive eggs are stuck to the gravel pebbles. The male bass guards the eggs until they hatch and assists the eggs in "breathing" by fanning over them with his fins. If the male bass is removed, the eggs will die or can be eaten by predators. It is poor conservation to take these adult bass off their nests in those ponds where it is desirable to improve or develop bass fishing. Most bass spawning takes place in June and this is the period when the adult males are guarding their nests. The present law of allowing fishermen to take 3 black bass per day by fly fishing from June 1 to June 20 has resulted in the destruction of a great many bass nests. Almost all of the bass fishing of early June that the writer has observed has been fishing by fly along the shallow waters where bass are guarding their nests or are spawning. Some fishermen who catch these spawning bass return them to the water and the bass return to their nests; probably little, if any, harm results from this disturbance. However, when the bass is seriously hooked and thus does not immediately return to the nest, the interruption probably results in some loss of eggs or fry. Where the bass is kept by the fisherman there is little or no chance that any of the eggs or fry will survive.

In order to build up a larger bass population in lakes suited to bass, it is in the interests of bass fishermen themselves that these spawning fish should be protected. Either one of the following methods are recommended: (1) prohibit bass fishing entirely in all bass lakes (not in lakes stocked with trout or salmon) at least until the general bass season opens on June 21; this restriction is very desirable. It would probably also be a considerable additional aid in increasing the bass population if the bass fishing season were not opened until July 1. (2) If the present bass fishing season is left as at present, then the main spawning grounds on each lake should be marked by stakes and fishing should be prohibited within 100 yards of these spawning areas during the entire month of June. This method of protecting spawning bass is being used in some of our neighboring states. This method would be very successful only in lakes where bass spawning grounds are greatly concentrated in small areas which could be marked off, and, furthermore, this method would be successful only if the fishermen themselves gave it their cooperation.

SUMMARY OF SURVEY RESULTS AND RECOMMENDATIONS ON STOCKING AND OTHER MANAGEMENT METHODS FOR EACH OF THE 31 LAKES AND PONDS

The following section of this report gives a brief summary of our survey findings for each of the lakes and ponds, together with recommendations on fish stocking and other management. Details concerning the development of a stocking policy suitable for these waters have been discussed in previous sections of this report. Much of the following data have already been presented in previous sections of this report but organized according to each particular phase of the survey program. The following section is an attempt to give, by lakes, a brief summary of these results so that most of the important information pertaining to each particular body of water is together as a unit.

KEY TO MAPS

Outline maps are given for each lake or pond in the following summary discussion of survey results. Preparation of these maps has been discussed in other sections of this report.

All numerical figures within outline of lake represent soundings in feet
Water analyses stations indicated by an ⊗
In the cross-section diagram headed by "suitability for trout and salmon during late summer"
- **"Suitability" means only from the standpoint of temperature and oxygen**
- **"Late summer" means during the end of the hot part of the summer, mostly during August**
- **"Water volume" refers to all water in the lake**
- **"Bottom area" refers to the entire lake bottom**
- **"Warm" means above 70° Fahrenheit**
- **"Trout" means trout, togue, and salmon, and probably applies also to such other cold-water fishes as smelt, whitefish and cusk**
- **"Low oxygen" means less than 5 p.p.m. of dissolved oxygen in the water**
- **Blackened area represents proportionate amount of water volume or bottom area not available to trout or salmon during late summer**
- **White area represents amount of water volume and bottom area available to trout and salmon during late summer**
- **"No trout or salmon water" means during late summer**

Pond reference numbers are indicated in the following form: P 155, P 238, P 302
Elev means elevation in feet above mean sea level, obtained from U. S. topographic maps
Area in acres obtained by using planimeter on lake outline on U. S. topographic maps
Direction arrows indicate true north
All maps by the writer

Sebago Lake and Long Lake (at Naples and Harrison) had been sounded previously by Dr. W. C. Kendall for the U. S. Bureau of Fisheries, and maps showing these soundings were available. Kezar Lake had been sounded by Mr. Herbert L. Flint, landscape architect. All of the soundings on Sebago and Long lakes and almost all on Kezar Lake are from these other surveys. The writer's thanks are offered for permission to use these data.

STANLEY POND, P. 155

(See map, Fig. 1)

Oxford County *Hiram and Porter* Townships

Area 137 acres *Elevation* 381 ft. *Maximum depth* 75 ft.

Stanley Pond was sounded on August 24 and found to be comparatively deep throughout most of its area. A maximum depth of 75 feet was found near the center of the middle portion of the pond.

Water analyses were made on August 24. The water was white and clear. The pH tests revealed a hydrogen ion concentration ranging from 6.9 at the surface to 5.9 at the bottom in 70 feet of water. A considerable oxygen deficiency in the deepest water indicated extensive organic decomposition.

Water analyses made on August 24 further indicated that water too warm for trout (above 70° F.) was found to extend down to a depth of 16 feet, and water with less than 5 p.p.m. of oxygen was found to extend up from the bottom to a depth of 45 feet. From these critical depths it was estimated that by the end of the summer the warm water would extend to 18 feet and the oxygen deficiency would extend up from the bottom to a depth of 42 feet. From these estimated depths it was calculated that during the most critical late-summer period the water in Stanley Pond is divided on the basis of its suitability to trout as follows:

Upper warm water, surface to 18 feet, no trout: 2,094 acre feet (49%) of water, 40 acres (29%) of bottom area

Middle layer, 18 to 42 feet, suitable for trout and salmon: 1,608 acre feet (38%) of water, 56 acres (41%) of bottom area

Lower layer, 42 to 75 feet, oxygen deficient, no trout: 544 acre feet (13%) of water, 41 acres (30%) of bottom area

From the standpoint of depth, temperature and oxygen, Stanley Pond may be classed as very good trout water.

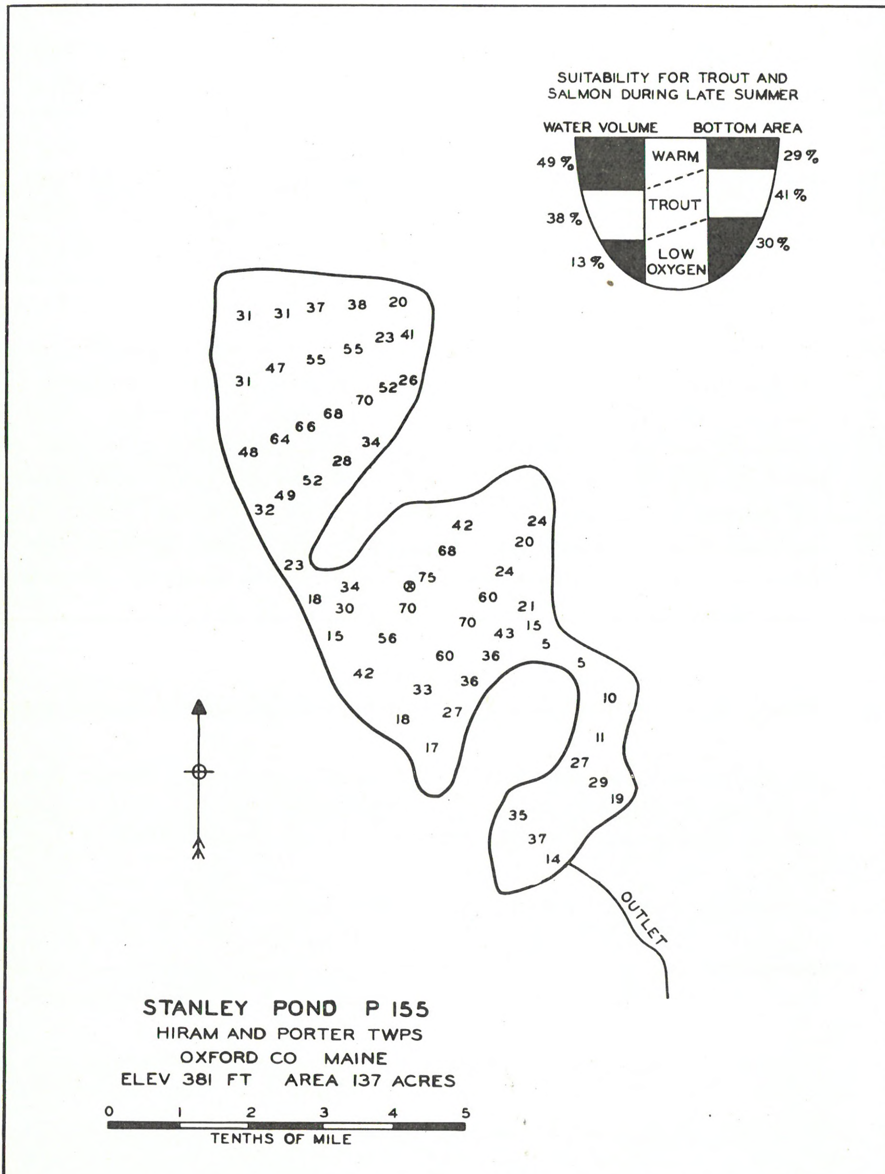
Soundings and the results of oxygen tests in deep water indicated that much of the bottom in the deep part of Stanley Pond was a thick layer of organic mud.

Plankton samples taken from the deep water of the pond indicated that the pond is not particularly rich.

The pond contains at least 3 species of warm-water game fishes, namely, the Yellow Perch, Common Pickerel and Horned Pout. The warm-water game fishes, however, are not at all abundant in this pond as compared to the other ponds which were surveyed. The combined competition factor for warm-water game fishes is CF = 5.

Stanley Pond was stocked during the fiscal year of 1937-38 with 10,000 Brown Trout, and the writer has no records of other stockings in this pond since 1933.

FIG. I


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
49 %
38 %
13 %
WARM
TROUT
LOW OXYGEN
29 %
41 %
30 %
OUTLET
STANLEY POND P 155
HIRAM AND PORTER TWPS
OXFORD CO MAINE
ELEV 381 FT AREA 137 ACRES
0 1 2 3 4 5
TENTHS OF MILE

Recommendations: In view of the fact that a very large proportion of both the water and the bottom of Stanley Pond is available to trout during the entire summer, it would be a better policy to stock this pond with native Brook Trout than to continue stocking with Brown Trout. Stocking recommendations are made on the basis of 97 acres of water suitable for supporting trout. This 97 acres is an average between the total area of the lake, which is 137 acres, and the area of the bottom which is available to trout and salmon during the late summer, which is 56 acres. On the basis of a III food grade, fair spawning conditions, a game fish competition factor of 5, and medium fishing intensity, the pond should be stocked at the rate of 20 six-inch fish per acre. This gives a total annual stocking of approximately 1,800 six-inch Brook Trout.

TRAFTON POND, P. 156

(See map, Fig. 2)

Oxford County — *Hiram and Porter* Townships

Area 56 acres — *Elevation* 388 ft. — *Maximum depth* 43 ft.

Trafton Pond was surveyed on August 24 and 25. The maximum depth of 43 feet was found near the center of the pond. About half of the pond is over 18 feet deep.

Water analyses on August 25 revealed warm water from the surface to a depth of 16 feet, and oxygen-deficient water from the bottom up to a depth of 25 feet. From these depths it was estimated that warm non-trout water would eventually extend to a depth of 18 feet and oxygen deficiency would extend up to a depth of 24 feet, leaving a six-foot layer of water suitable for trout during late summer. During the late summer period the pond is divided into the following:

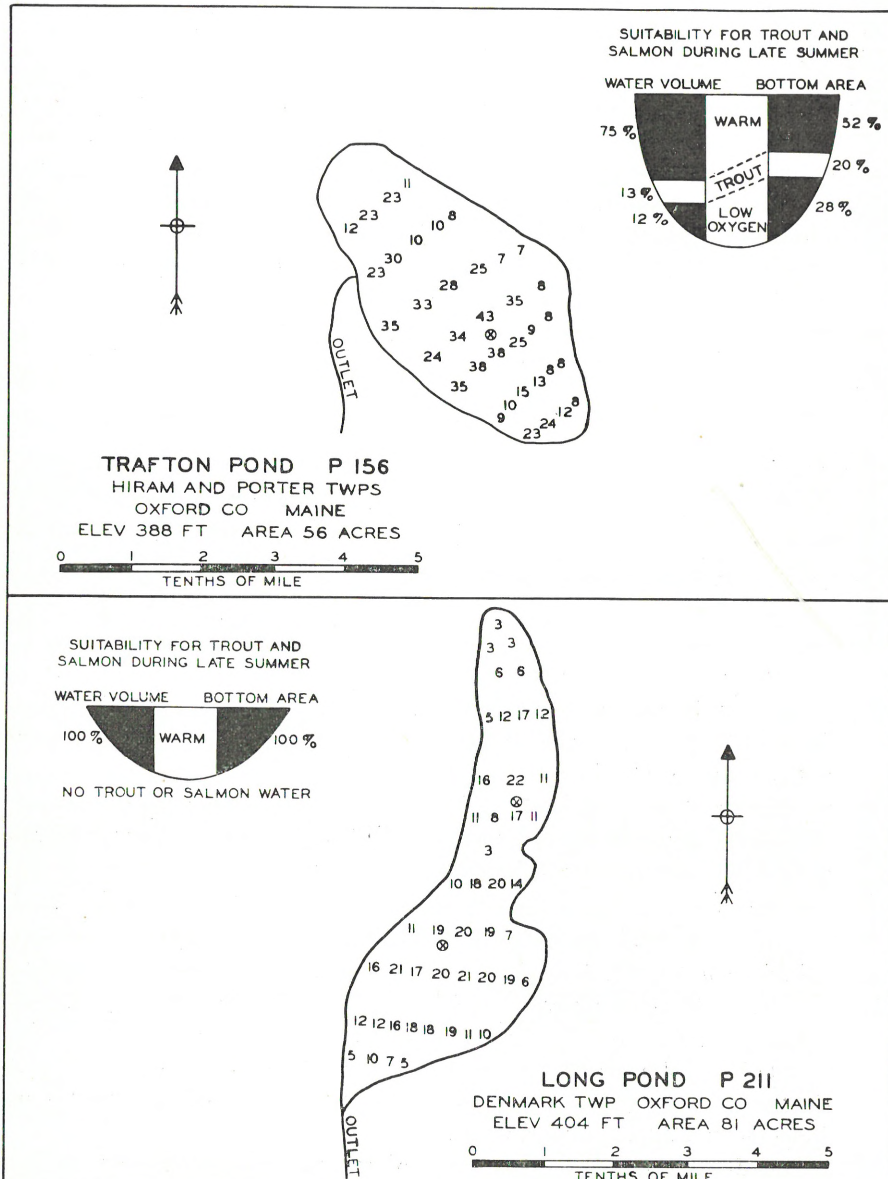
- Upper warm water, surface to 18 feet, no trout: 732 acre feet (75%) of water, 29 acres (52%) of bottom area
- Middle layer, 18 to 24 feet, suitable for trout and salmon: 128 acre feet (13%) of water, 11 acres (20%) of bottom area
- Lower layer, 24 to 43 feet, oxygen deficient, no trout: 115 acre feet (12%) of water, 16 acres (28%) of bottom area

On the basis of these figures Trafton may be classed as a fair trout pond from the standpoint of the water.

Soundings revealed a thick layer of organic mud on the bottom and oxygen tests indicated extensive decomposition of this bottom material in the deep water.

Plankton food organisms were about average in abundance, and the pond was given a food grade of III.

FIG. 2


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
75 %
13 %
12 %
52 %
20 %
28 %
OUTLET
TRAFTON POND P 156
HIRAM AND PORTER TWPS
OXFORD CO MAINE
ELEV 388 FT AREA 56 ACRES
0 1 2 3 4 5
TENTHS OF MILE
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
100 %
100 %
NO TROUT OR SALMON WATER
OUTLET
LONG POND P 211
DENMARK TWP OXFORD CO MAINE
ELEV 404 FT AREA 81 ACRES
0 1 2 3 4 5
TENTHS OF MILE

The warm-water game fishes present were Yellow Perch, Pickerel and Horned Pout, representing a competition factor of 6 for trout. The Smelt was not known to be present.

Trafton Pond was stocked with 3,900 Brook Trout in 1934-35.

Recommendations: Yearly stocking of 350 six-inch Brook Trout. If this stocking does not produce some fishing, after two years, stock with 350 six-inch Brown Trout.

BARKER POND, P. 169

(See map, Fig. 3)

Oxford County		*Hiram* Township
Area 206 acres	*Elevation* 491 ft.	*Maximum depth* 44 ft.

Barker Pond was surveyed on August 25. A maximum depth of 44 feet was found in the southern part of the pond. Only 30 per cent of the pond is over 18 feet deep.

Water analyses on August 25 revealed warm water extending to a depth of 16 feet and oxygen-deficient water extending up to a depth of 17 feet. There was, theoretically, a 1-foot layer of trout water on this date, from which fact it was estimated that trout water would be entirely absent by the end of the summer at which time the lake would be divided into the following:

Upper warm water, surface to 18 feet, no trout: 2,496 acre feet (70%) of water, 125 acres (61%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 17 to 44 feet, oxygen deficient, no trout: 1,179 acre feet (33%) of water, 96 acres (47%) of bottom area

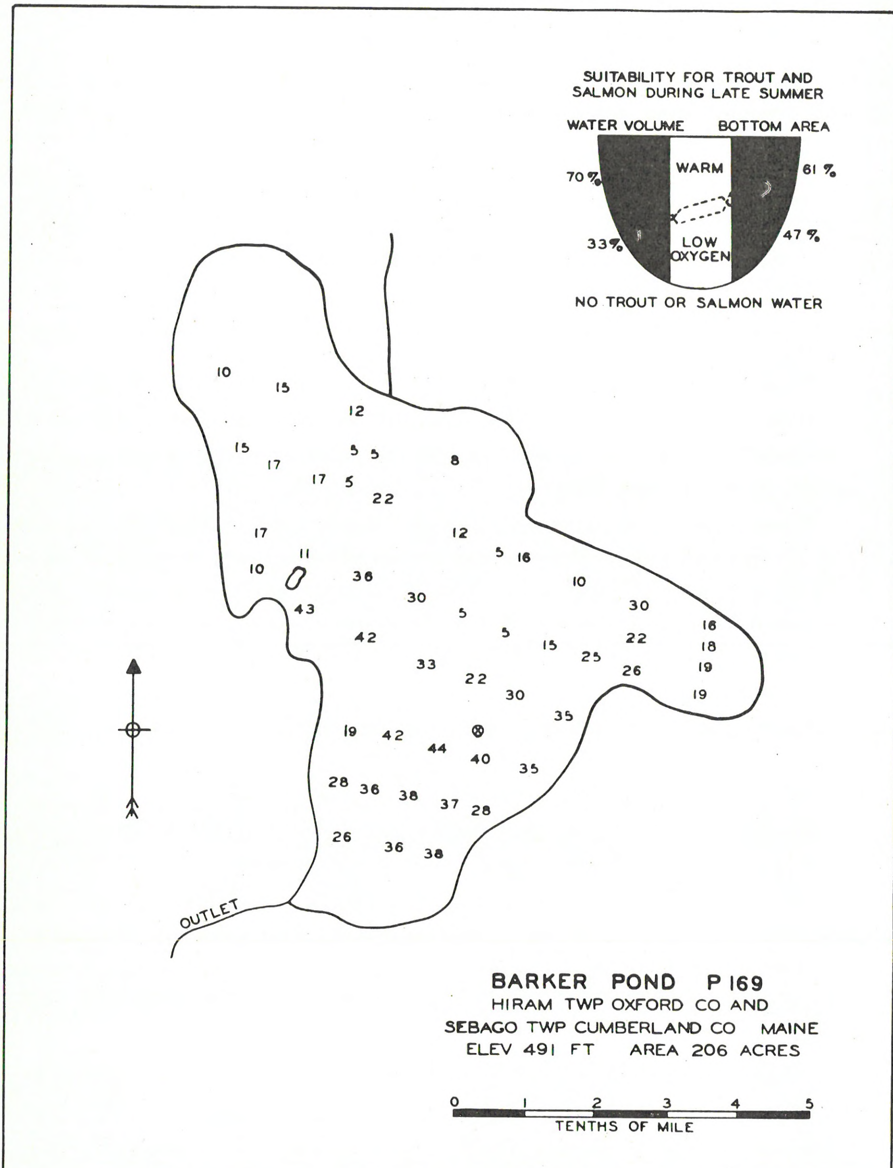
Plankton organisms were quite rare, but the pond had a fairly good minnow population; it was therefore given a II food grade for bass.

The game fishes present were Yellow Perch, Small-mouthed Bass, Pickerel, and Horned Pout. Bass were rare and should have been abundant in this pond.

There are no records of stocking Barker Pond during the past five years.

Recommendations: Do not stock any trout or salmon or any other cold-water fish in Barker Pond. Stock yearly 800 three-inch Small-mouthed Bass fingerlings. Close the pond to fly fishing for bass at least until June 21, preferably until July 1.

FIG. 3



SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
70 %
61 %
33 %
47 %
LOW OXYGEN
NO TROUT OR SALMON WATER
10
15
12
15
17
5
5
8
17
5
22
17
12
11
5
16
10
38
10
30
30
43
5
16
42
5
15
22
18
25
33
26
19
22
30
19
35
19
42
44
40
35
28
36
38
37
28
26
36
38
OUTLET
BARKER POND P 169
HIRAM TWP OXFORD CO AND
SEBAGO TWP CUMBERLAND CO MAINE
ELEV 491 FT AREA 206 ACRES
0
1
2
3
4
5
TENTHS OF MILE

GRANGER POND, P. 180

(See map, Fig. 4)

Oxford County | *Denmark* Township

Area 125 acres | *Elevation* 525 ft. | *Maximum depth* 28 ft.

Granger Pond was surveyed on June 28. The maximum depth of 28 feet was found in the southern part of the pond. Only 30 per cent of the pond was over 18 feet deep. The water was brown in color.

On June 28, warm non-trout water extended down to 14 feet and water with less than 5 p.p.m. of oxygen extended up to 26 feet. Since oxygen depletion already had been considerable it was estimated that depletion would extend at least up to 20 feet, and the estimated maximum depth of depression of warm water was 18 feet. This left, at best, only a 2-foot layer of trout water, and a classification of the pond as follows:

Upper warm water, surface to 18 feet, no trout: 1,478 acre feet (91%) of water, 87 acres (70%) of bottom area

Middle layer, 18 to 20 feet, suitable for trout and salmon: 66 acre feet (4%) of water, 10 acres (8%) of bottom area

Lower layer, 20 to 28 feet, oxygen deficient, no trout: 75 acre feet (5%) of water, 28 acres (22%) of bottom area

Granger Pond has too little water suitable for trout or salmon to justify stocking these species.

The pond contains Yellow Perch, Pickerel and Horned Pout. The questionaire to the local Game Wardens indicated that bass might be present, but one local resident reported bass as absent.

Recommendations: Stock no trout or salmon of any kind. Stock 50 adult Small-mouthed Bass as a brood stock the first year; stock yearly 500 three-inch Small-mouthed Bass fingerlings.

MOOSE POND, LOWER, MIDDLE, AND UPPER, P. 179, P. 181, P. 182

(See map, Fig. 5)

Oxford, Cumberland Counties | *Denmark, Sweden, Bridgton* Townships

LOWER PART, P. 179

Area 388 acres | *Elevation* 418 ft. | *Maximum depth* 33 ft.

MIDDLE PART OR MAIN LAKE, P. 181

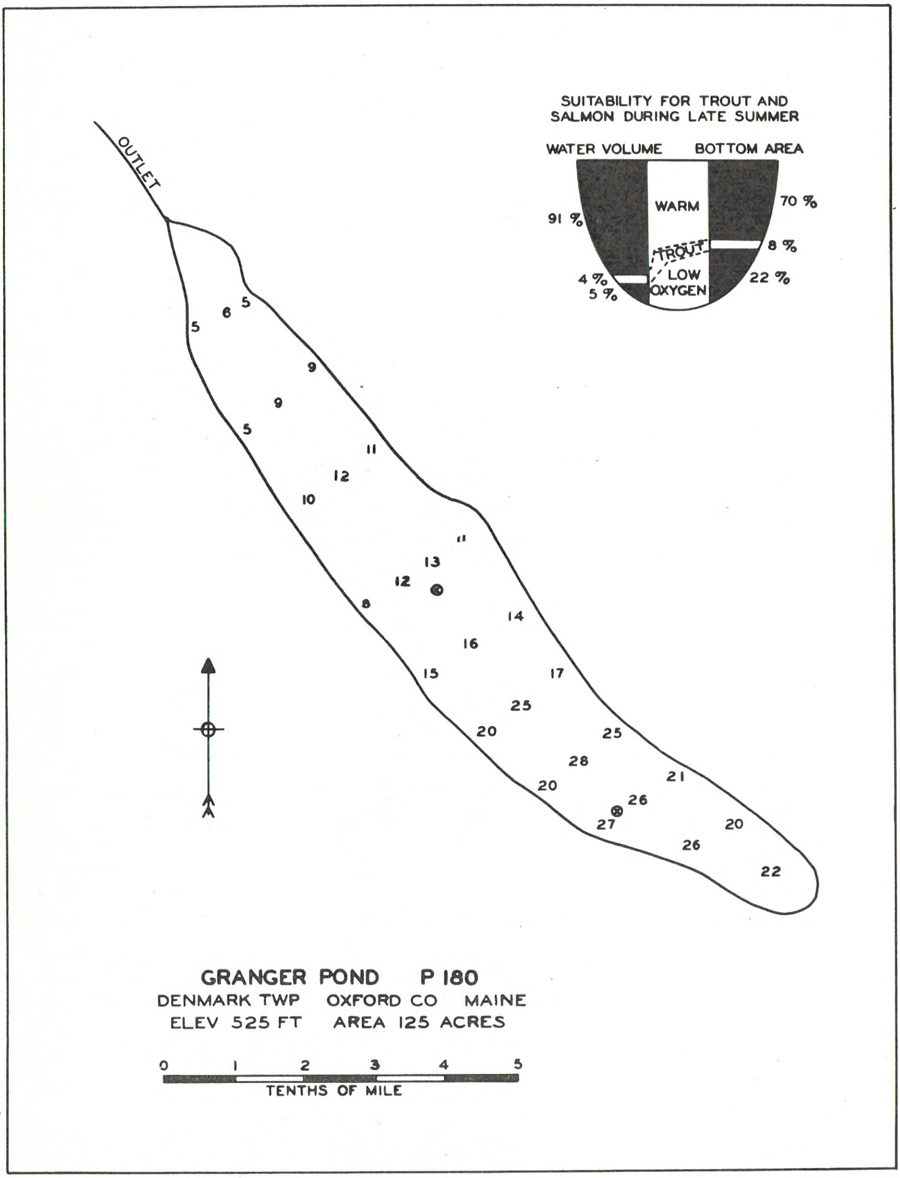
Area 941 acres | *Elevation* 418 ft. | *Maximum depth* 70 ft.

UPPER PART, P. 182

Area 365 acres | *Elevation* 418 ft. | *Maximum depth* 18 ft.

The three sections of Moose Pond are closely connected so that pond fishes can migrate readily from one to another, but these ponds are distinctly of three different types with respect to their suitability for different

FIG. 4


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
91 %
70 %
8 %
TROUT
LOW OXYGEN
4 %
5 %
22 %
OUTLET
5
6
5
5
9
9
5
11
12
10
11
13
12
8
14
16
15
17
25
20
25
28
21
20
26
27
20
26
22
GRANGER POND P 180
DENMARK TWP OXFORD CO MAINE
ELEV 525 FT AREA 125 ACRES
0
1
2
3
4
5
TENTHS OF MILE

species of game fishes. The ponds were studied during the period of July 15 to 18.

The lower part (P. 179) has a maximum depth of 33 feet near the east shore. Only 20 per cent of the lake is over 20 feet deep. From water analyses it was concluded that the pond has no trout or salmon water at all during late summer:

Upper warm water, surface to 20 feet, no trout: 4,280 acre feet (93%) of water, 309 acres (80%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 20 to 33 feet, oxygen deficient, no trout: 342 acre feet (7%) of water, 79 acres (20%) of bottom area

The middle or main part (P. 181) of Moose Pond has a maximum depth of 70 feet. Fifty-nine per cent of the pond is over 25 feet deep. Water analyses indicated that this main part of Moose Pond has excellent trout and salmon water. On July 16, the warm (above 70° F.) water extended to a depth of 17 feet, but the oxygen content of the deep water was very good (7.6 p.p.m. at 64 feet). From these analyses it was estimated that warm water would extend to 25 feet by the end of the summer but that there would be more than 5 p.p.m. of oxygen throughout the deep water all summer. From the standpoint of trout and salmon, this main part of Moose Pond is divided as follows:

Upper warm water, surface to 25 feet, no trout: 18,450 acre feet (70%) of water, 389 acres (41%) of bottom area

Middle layer, 25 to 70 feet, suitable for trout and salmon: 7,894 acre feet (30%) of water, 552 acres (59%) of bottom area

Lower layer, oxygen deficient, no trout: None

The upper part (P. 182) of Moose Pond, above the bridge at West Bridgton, is very shallow. Only about 9 per cent of the pond is over 11 feet deep. It was estimated to be too warm for trout at all depths.

The lower part (P. 179) was given a II food grade on the basis of an abundant plankton population, and a fair minnow supply. The main lake was given a II food grade for salmon largely on the warden report of Smelt being common.

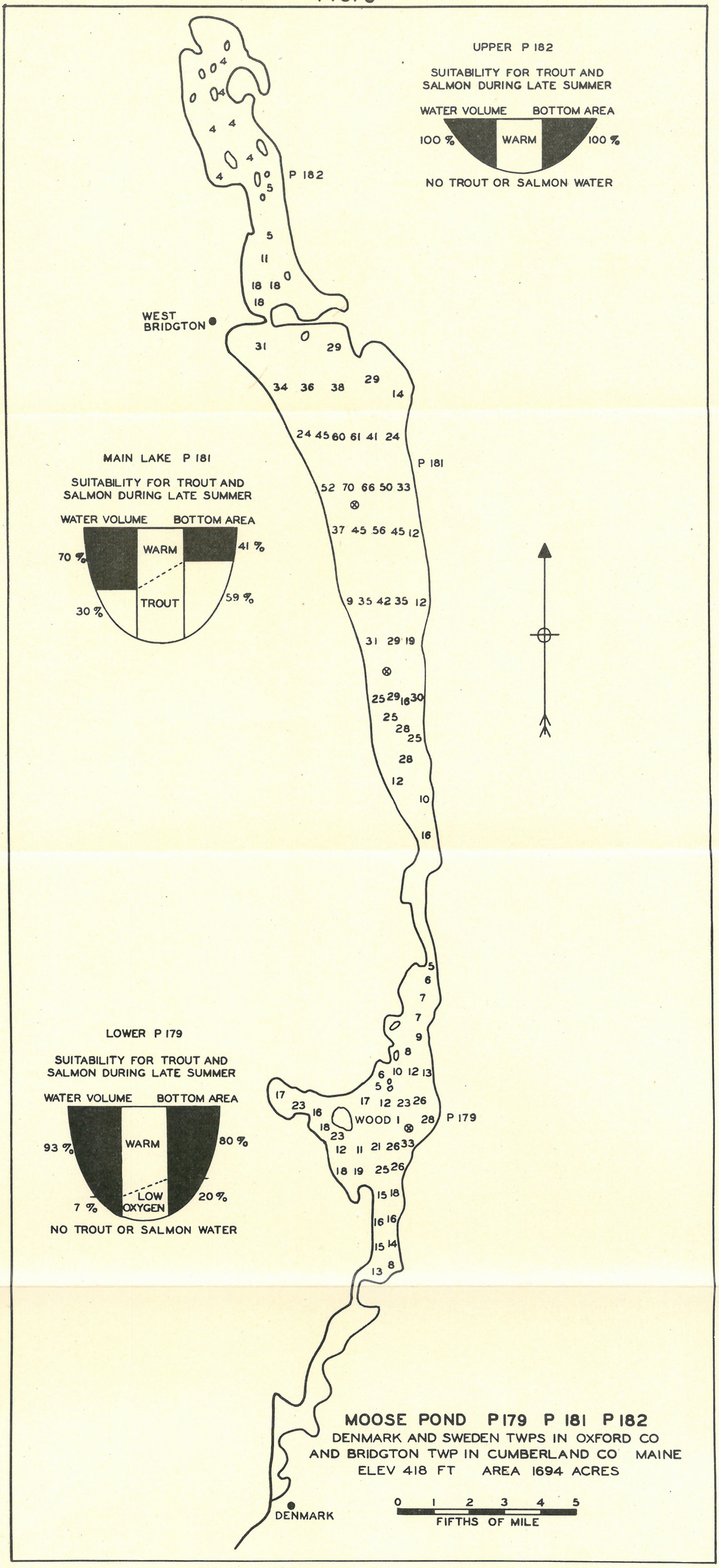
All three parts of Moose Pond contain Yellow Perch, White Perch, and Pickerel, and these three species are abundant in the pond as a whole. Together with bass and Horned Pout, they present considerable competition to trout or salmon, or competition factors of 11, 12 and 12 for the three parts of the pond.

The main part of Moose Pond has been stocked quite heavily with salmon every year for the past five years; the total for this period is:

15,000 two- to four-inch Land-locked Salmon

26,000 four- to six-inch Land-locked Salmon

FIG. 5


UPPER P 182
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
100 %
WARM
100 %
NO TROUT OR SALMON WATER
P 182
WEST BRIDGTON
MAIN LAKE P 181
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
70 %
WARM
41 %
30 %
TROUT
59 %
P 181
LOWER P 179
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
93 %
WARM
80 %
7 %
LOW OXYGEN
20 %
NO TROUT OR SALMON WATER
WOOD I
P 179
DENMARK
MOOSE POND P179 P 181 P 182
DENMARK AND SWEDEN TWPS IN OXFORD CO
AND BRIDGTON TWP IN CUMBERLAND CO MAINE
ELEV 418 FT AREA 1694 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

3,500 "mature" (over 6 inches) Land-locked Salmon
10,000 "mature" (over 6 inches) Chinook Salmon

Local reports indicate that salmon fishing should be better in view of this extensive stocking.

Recommendations: Continue yearly stocking the main part (P. 181) of Moose Pond with 11,300 six-inch Land-locked Salmon. Stock Smelt by transplanting eggs to tributary streams of the main lake. Prohibit taking of smelts in any way from the main lake or its tributaries.

Install fish screen under the bridge at West Bridgton, between the main lake and the upper section of the pond. This upper section is an ideal breeding ground for pickerel and perch and these fish should be kept out of the main lake, if stocking of the main lake with salmon is continued.

Install fish screen under the bridge at the narrows between the main part of Moose Pond and the lower part (P. 179), to keep perch and pickerel from the lower part out of the main lake.

Remove all legal restrictions on size limit, bag limit, or season on warm-water game fishes in the main part of Moose Pond.

No stocking of trout or salmon in the lower part of Moose Pond. If a good and permanent screen is installed in the narrows between the lower and main parts of Moose Pond, stock the lower part (P. 179) yearly with 2,700 three-inch Small-mouthed Bass fingerlings; if such a screen is not installed, do not stock bass. Large numbers of bass should not get into the main lake.

BEAVER POND, P. 183

(See map, Fig. 6)

Cumberland County		*Bridgton* Township
Area 69 acres	*Elevation* 473 ft.	*Maximum depth* 35 ft.

Beaver Pond was examined July 21 to 25. A depth of 35 feet was found near the center of the pond. Seventy per cent of the pond is less than 15 feet deep.

On July 25 warm water extended to a depth of 11 feet and oxygen deficiency extended up to a depth of 15 feet. By the end of summer this pond has no trout water at all; the estimated figures are as follows:

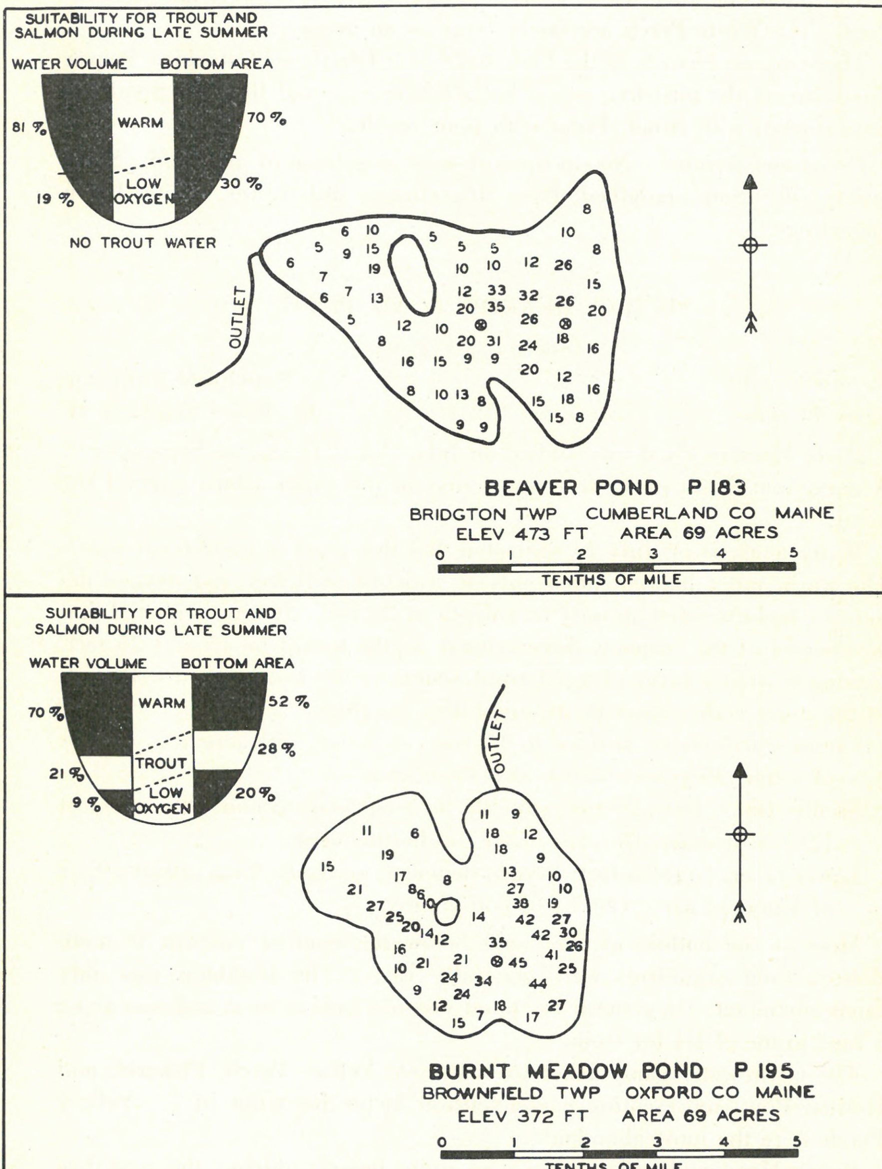
Upper warm water, surface to 15 feet, no trout: 657 acre feet (81%) of water, 48 acres (70%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 15 to 35 feet, oxygen deficient, no trout: 153 acre feet (19%) of water, 21 acres (30%) of bottom area

The pond bottom has a thick layer of organic mud, associated with excessive decomposition in the deep water. Few if any fish could live below a depth of 18 feet during late summer.

FIG. 6



SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
LOW OXYGEN
81 %
19 %
70 %
30 %
NO TROUT WATER
OUTLET
BEAVER POND P 183
BRIDGTON TWP CUMBERLAND CO MAINE
ELEV 473 FT AREA 69 ACRES
0 1 2 3 4 5
TENTHS OF MILE
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
70 %
21 %
9 %
52 %
28 %
20 %
OUTLET
BURNT MEADOW POND P 195
BROWNFIELD TWP OXFORD CO MAINE
ELEV 372 FT AREA 69 ACRES
0 1 2 3 4 5
TENTHS OF MILE

Plankton food organisms were quite rare. The pond was given a food grade of III on the basis of the scarcity of plankton and minnows.

The pond contains White Perch, Yellow Perch, Pickerel, and Horned Pout. The White Perch are fairly large as an average.

There are no records of the Fish and Game Department stocking Beaver Pond during the past five years, but wardens reported that the pond has been stocked with Brook Trout with poor results.

Recommendations: No stocking of trout or salmon of any kind. Stock yearly 300 Small-mouthed Bass fingerlings, and 1,000 White Perch fingerlings.

BURNT MEADOW POND, P. 195

(See map, Fig. 6)

Oxford County		*Brownfield* Township
Area 69 acres	*Elevation* 372 ft.	*Maximum depth* 45 ft.

Burnt Meadow Pond was studied on July 14 and 15 and on September 1. A maximum depth of 45 feet was found in the southeastern part of the pond.

Water analysis on July 14 indicated that this pond is good trout water. The warm water had extended only to a depth of 8 feet and oxygen deficiency had extended up only to a depth of 30 feet. It was estimated that by the end of the summer, these critical depths would be 15 and 25 feet, leaving a 10-foot layer of good trout water, or the following distribution of the pond with respect to its suitability for trout:

Upper warm water, surface to 15 feet, no trout: 750 acre feet (70%) of water, 36 acres (52%) of bottom area

Middle layer, 15 to 25 feet, suitable for trout and salmon: 227 acre feet (21%) of water, 19 acres (28%) of bottom area

Lower layer, 25 to 45 feet, oxygen deficient, no trout: 93 acre feet (9%) of water, 14 acres (20%) of bottom area

Most of the bottom of the pond below the ten-foot contour is mud. Bottom food organisms were generally rare. The plankton was only fairly abundant. In general the pond was not rich in food and was given a food grade of III for trout.

The warm-water game fishes present were Yellow Perch, Pickerel, and Horned Pout, representing a competition factor for trout of 7. Yellow Perch were the most abundant.

Burnt Meadow Pond was stocked quite heavily during the past five years with a total of 10,000 four- to six-inch, and 2,000 "mature" Brook Trout. Yet no trout were taken by netting and warden reports indicate that Brook Trout are present but rare. It is believed that the present abundance of Yellow Perch and Pickerel is partially responsible for the scarcity of trout in this pond.

Recommendations: Continue stocking Brook Trout at the rate of 700 six-inch fish per year for the next two years. If this does not produce good trout fishing, poison the pond to remove all fish, and then stock Brook Trout at the rate of 1,500 six-inch fish per year.

LONG POND, P. 211

(See map, Fig. 2)

Oxford County — *Denmark* Township

Area 81 acres — *Elevation* 404 ft. — *Maximum depth* 22 ft.

Long Pond (P. 211) was examined on July 11 and 12. Most of the pond is less than 20 feet deep. The two deepest parts are separated by a shallow narrows across the middle of the pond.

On July 11, the water was above 70° F. down to depths of 15 to 18 feet. By the end of the summer, warm non-trout water would undoubtedly extend to the bottom throughout the entire pond. Oxygen content was high at all depths; the high oxygen content in deep water was associated with the fact that the bottom of the pond has only a thin layer of organic mud. The water is white and very clear. The pond was found to be quite rich in plankton and was given a general food grade of II.

The game fishes most common were the Yellow Perch and Pickerel. Minnows were listed in warden reports as being common. There were no bass present. There are no records of the pond being stocked during the past five years.

Recommendations: Stock no trout or salmon in the pond in view of the present populations of Yellow Perch and Pickerel. Stock pond with 50 adult Small-mouthed Bass as a brood stock.

There is a fairly good possibility that Long Pond would support some trout if there were absolutely no perch, pickerel or other warm-water game fishes present, even in spite of the fact that fairly warm water extends completely to the bottom. If, after about five years, the pond produces little or no bass fishing, it could be reclaimed for trout; poison the pond to remove perch, pickerel and bass, and stock yearly with 800 six-inch Brown Trout.

KEZAR LAKE, LOWER, MIDDLE AND UPPER BAYS, P. 233, P. 238

(See map, Fig. 7)

Oxford County | *Lovell* Township

LOWER BAY, P. 233

Area 684 acres | *Elevation* 376 ft. | *Maximum depth* 17 ft.

MIDDLE AND UPPER BAYS, P. 238

Area 1,826 acres | *Elevation* 376 ft. | *Maximum depth* 155 ft.

The Lower Bay of Kezar Lake is sufficiently separated from the main lake to constitute a unit by itself, and these two parts of Kezar Lake are of very different types. The Lower Bay has a maximum depth of 17 feet, but almost all of it is less than 11 feet deep. The unit comprising the Middle and Upper Bays has a maximum depth of 155 feet just off Bryant Hill. This main part of Kezar Lake is divided according to depth as follows:

860 acres of bottom area between 0 and 25 feet deep
567 acres of bottom area between 25 and 80 feet deep
287 acres of bottom area between 80 and 120 feet deep
112 acres of bottom area between 120 and 155 feet deep

During the summer, the Lower Bay of Kezar is too warm for trout or salmon from the surface to the bottom. The water in the main lake, however, is excellent for salmon. Water analyses on July 19 in 147 feet of water revealed the following: Warm water (above 70° F.) extended to a depth of about 18 feet. The temperature dropped very rapidly, with increase in depth, to 50° F. at 40 feet, and to 44.5° F. at 60 feet. The change in temperature from 60 to 140 feet was very slight—temperature 42.3° F. at 140 feet. The pH was slightly acid at the surface (6.9) and quite acid in deep water (6.0). The oxygen content remained very high to a depth of 120 feet, with a slight depression in oxygen below 120 feet due to a small amount of decomposition in the very deep water. Water analyses at four other stations indicated that temperature, oxygen and pH were about the same at corresponding depths over the lake. On the basis of these analyses it was calculated that, by the end of the summer, the main part of Kezar Lake would be divided up with respect to water suitable for salmon as follows:

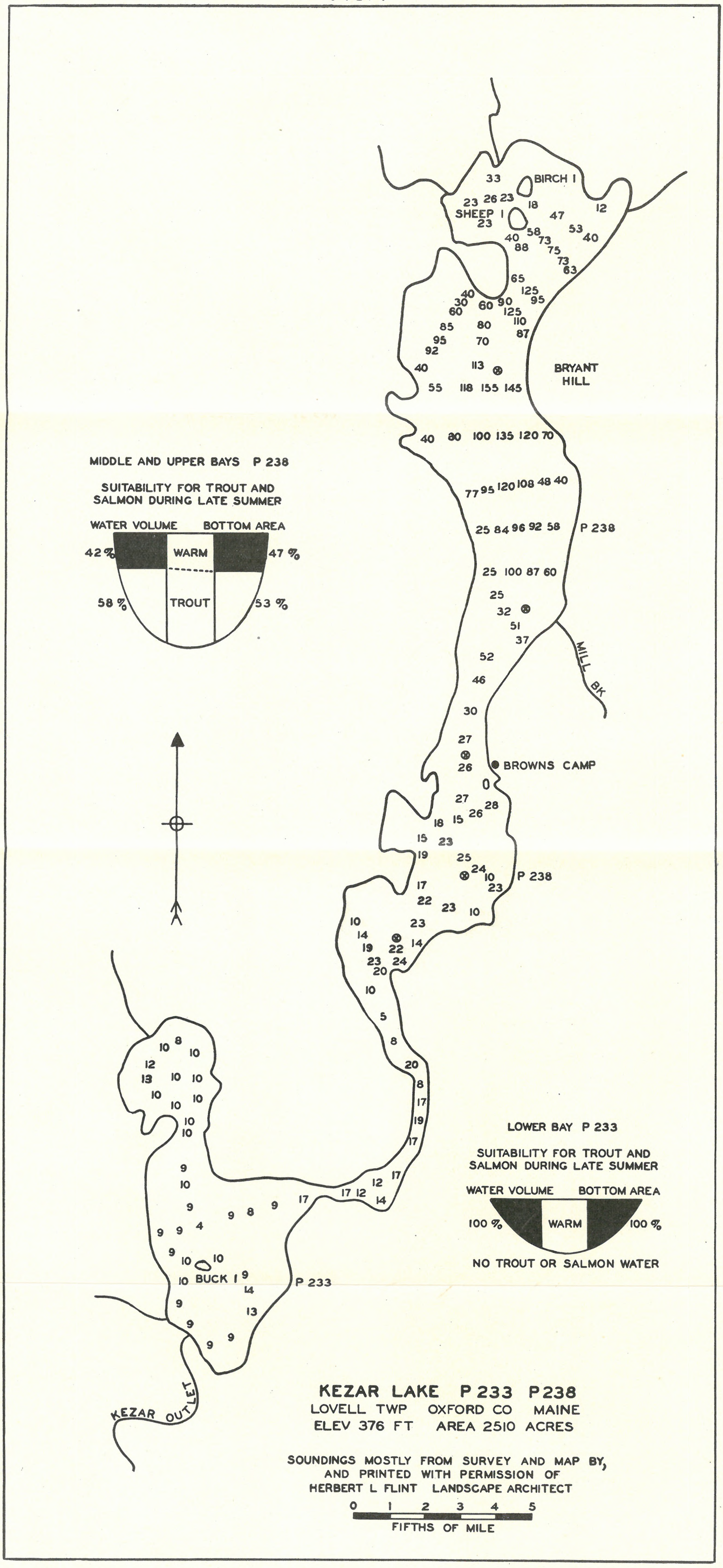
Upper warm water, surface to 25 feet, no trout or salmon: 34,333 acre feet (42%) of water, 860 acres (47%) of bottom area

Middle layer, 25 to 155 feet, suitable for trout and salmon: 47,344 acre feet (58%) of water, 966 acres (53%) of bottom area

Lower layer, oxygen deficient, no trout: None

The bottom material in the Lower Bay of Kezar is mostly mud. The bottom of the main lake is mostly mud in deep water but much of the drop-off area around the margin is rock. The 17 samples of bottom food organisms in the main lake yielded a very small fish food supply; this

FIG. 7


MIDDLE AND UPPER BAYS P 238
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
42 %
WARM
47 %
58 %
TROUT
53 %
LOWER BAY P 233
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
100 %
WARM
100 %
NO TROUT OR SALMON WATER
BIRCH I
SHEEP I
BRYANT HILL
P 238
MILL BK
BROWNS CAMP
P 238
BUCK I
P 233
KEZAR OUTLET
KEZAR LAKE P 233 P 238
LOVELL TWP OXFORD CO MAINE
ELEV 376 FT AREA 2510 ACRES
SOUNDINGS MOSTLY FROM SURVEY AND MAP BY, AND PRINTED WITH PERMISSION OF HERBERT L FLINT LANDSCAPE ARCHITECT
0 1 2 3 4 5
FIFTHS OF MILE

emphasizes the importance of the plankton and smelt food chain to the salmon population. The main lake was graded II for food for salmon on the basis of a fairly rich plankton population and a fair supply of smelts.

Kezar Lake contains fairly abundant populations of about all of the warm-water game fishes common to Maine, namely the White Perch, Yellow Perch, Small-mouthed Bass and Pickerel. Judging from survey estimates, these warm-water species are about as abundant in Lower Bay as in the main lake (CF = 15 in each). There is no doubt but that their abundance is a threat to the smelt population and thus to salmon fishing in the lake. The smelt population of Kezar has declined considerably in the past. We have some evidence that the salmon in Kezar are now feeding on Yellow Perch about as much as on the Smelt. It is very probable that the Smelt is fighting a losing battle to maintain itself in Kezar, and, if and when the Smelt is gone, continued stocking of salmon will do little to maintain salmon fishing.

Kezar Lake has been stocked heavily with Land-locked Salmon during the past five years to the extent of 20,000 fry, 21,000 two- to four-inch fingerlings, 74,543 four- to six-inch fingerlings, and 4,000 "mature" (over 6 inches) fish.

Recommendations: Since the main part of Kezar Lake is one of the best salmon lakes in the southern part of Maine, it seems to the writer that salmon fishing should be given foremost consideration in the management of the lake. However, the sportsmen and local residents about Kezar Lake should determine what kind of fishing they want most—either salmon fishing on the one hand or fishing for bass and other warm-water game fishes on the other. It is the writer's firm belief that good fishing can not be maintained for both. Any considerable improvement for bass fishing will be at the expense of salmon fishing.

If salmon fishing is desired, then the following recommendations are in order: On the basis of 1,396 acres of water supporting salmon, a II food grade, heavy fishing intensity, and good spawning grounds, an annual stocking of 16,700 six-inch fingerling Land-locked Salmon is recommended. Discontinue stocking fry and two- to four-inch fingerlings in the lake; if such small fish must be planted, stock them in the tributaries. Prohibit taking of Smelt from the lake and its tributary streams at any time. Do not stock any warm-water game fishes (including bass) in either the Lower Bay or the main lake. Remove all legal restrictions on taking warm-water game fishes from the entire lake. This is recommended in the interest of improving the lake for salmon; such a procedure is justified if the state is to go to the expense of raising over 16,000 six-inch salmon for the lake each year.

If improvement of fishing for bass and other warm-water game fishes is desired, it is recommended that stocking with salmon (and trout) be discontinued. To improve the lake for bass fishing, the present law of prohibiting bass fishing until the first of July is very desirable in order to protect the spawning bass; also stock yearly 11,000 three-inch Small-mouthed Bass fingerlings.

SEBAGO LAKE, P. 291

(See map, Fig. 8)

Cumberland County

Area 28,771 acres *Elevation* 262 ft. *Maximum depth* 316 ft.

Sebago Lake was studied during the period of August 4 to 11 and during September. The lake, as sounded by Dr. Kendall has a maximum depth of 316 feet near the center of the main part of the lake. We readily located 300 feet of water during our survey. The lake is divided according to depth as follows (the figures are approximate):

5,983 acres of bottom area between 0 and 30 feet deep
14,814 acres of bottom area between 30 and 150 feet deep
3,096 acres of bottom area between 150 and 200 feet deep
4,476 acres of bottom area between 200 and 300 feet deep
402 acres of bottom area between 300 and 316 feet deep

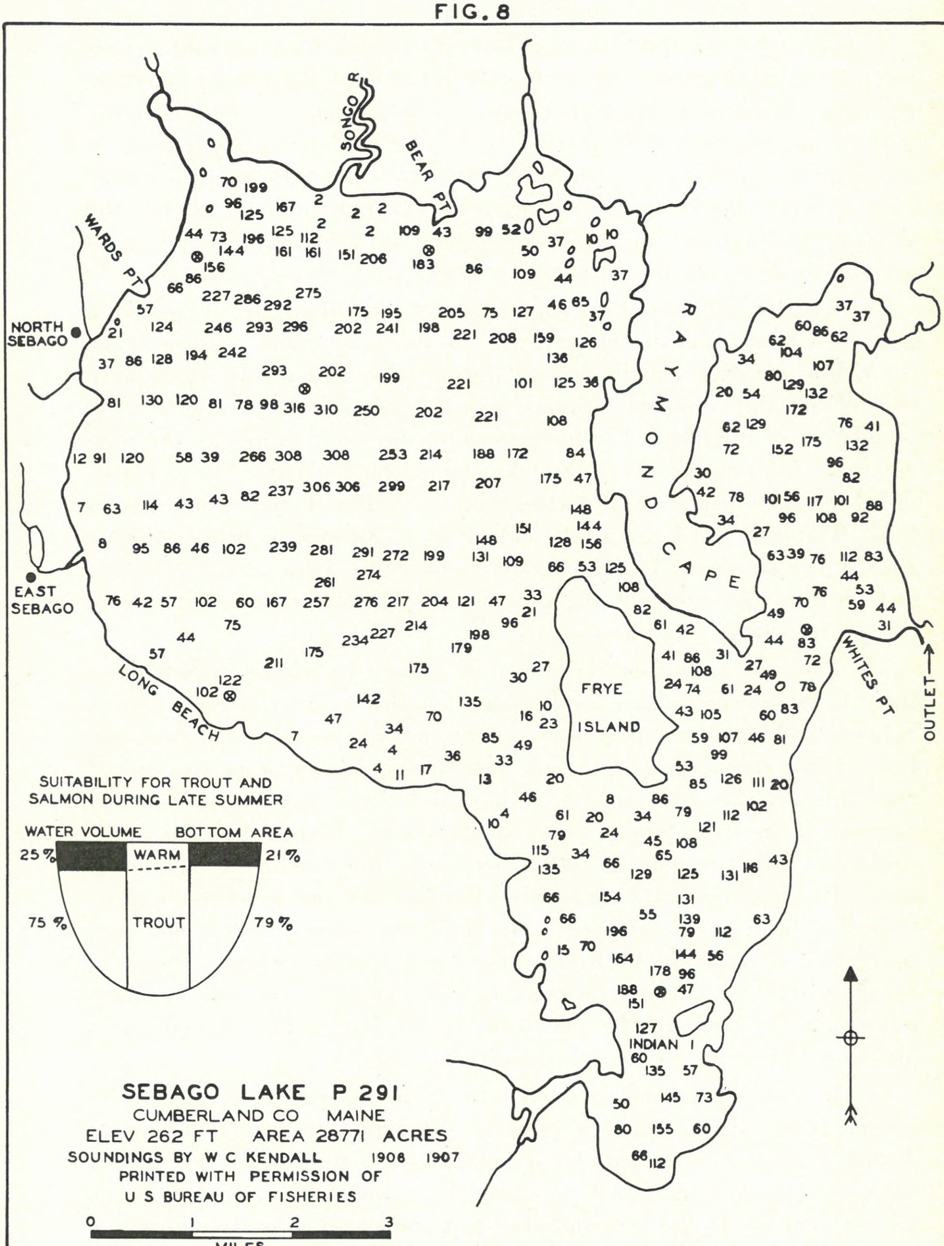
Water analyses were made during the period of August 4 to 9, at six stations scattered over the lake (see Table II). The water was white and very clear. The pH was mostly slightly alkaline (7.1) at the surface and only moderately acid (6.4 to 6.6) at depths of over 100 feet. Warm water (above 70° F.) was found to extend to somewhat different depths at different points on the lake, but the average was about 26 feet. The thermocline was very sharp and extended to a depth of about 50 feet. Below 50 feet the drop in temperature was very slow from the high forties at 50 feet to the low forties at 100 feet and to 41.0° F. at 300 feet. The oxygen content of the water was near saturation at all depths, increasing steadily from the surface to the bottom. The very high oxygen content at 300 feet indicated practically no organic decomposition in the deep water. Samples of water from 300 feet proved to be excellent for drinking, with no discernable trace of odor or impurities. On the basis of these analyses it was calculated that the water in Sebago Lake during the most critical late summer period is divided as follows:

Upper warm water, surface to 30 feet, no trout or salmon: 771,640 acre feet (25%) of water, 5,983 acres (21%) of bottom area

Middle layer, 30 to 316 feet, suitable for trout and salmon: 2,312,641 acre feet (75%) of water, 22,788 acres (79%) of bottom area

Lower layer, oxygen deficient, no trout: None

FIG. 8


SONGO R
BEAR PT
WARDS PT
NORTH SEBAGO
EAST SEBAGO
LONG BEACH
RAYMOND CAPE
FRYE ISLAND
WHITES PT
OUTLET
INDIAN I
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
25 %
WARM
21 %
75 %
TROUT
79 %
SEBAGO LAKE P 291
CUMBERLAND CO MAINE
ELEV 262 FT AREA 28771 ACRES
SOUNDINGS BY W C KENDALL 1906 1907
PRINTED WITH PERMISSION OF
U S BUREAU OF FISHERIES
0 1 2 3
MILES

The water in Sebago Lake is excellent for cold-water fishes from the standpoints of temperature and oxygen.

Twenty-eight samples of bottom soil and bottom food organisms were taken at depths ranging from 13 to 120 feet at widely scattered points on the lake. From these samples it was concluded that over most of those parts of the lake less than 100 feet deep, the bottom is mostly sand or clay with a very thin layer of silt deposit—every sample contained mostly sand or clay. Bottom food organisms were extremely rare; none of the 28 samples contained an important amount of food organisms, and 10 samples in 55 to 120 feet of water contained no food organisms at all.

The scarcity of bottom food emphasizes the importance of the plankton and smelt food chain of Sebago Lake for the game fishes. Sebago gave the richest plankton samples of all the 31 lakes and ponds which were studied, and this probably explains, at least partially, the enormous smelt population of the lake. The importance of the smelt supply to the food and game fish populations of the lake can not be doubted. The stomachs of all the game fishes (Land-locked Salmon, Yellow Perch, White Perch, Cusk, Whitefish, and large Smelt), which were collected by gill net during August, contained small smelts almost exclusively. Inquiries to fishermen and wardens were met with the consistent reply that salmon caught from Sebago invariably contain smelt.

The food and game fishes known to be present in Sebago include those listed in the preceding paragraph plus a few Brook Trout, a few Chinook Salmon, and Small-mouthed Bass, Common Pickerel, Horned Pout and Eels. Other species present include sunfish, two species of suckers and at least three species of minnows. The Land-locked Salmon is the only member of the trout family which is abundant. Three other species of cold-water fishes, namely the Whitefish, Cusk, and Smelt, are also abundant. Of the warm-water game fishes the bass and two perches might be classed as being fairly common in the shallower water. It does not seem likely that competition by these warm-water species against salmon in Sebago would ever be very serious due to the great expanse of very deep water and the fact that the two links in the food chain for salmon—plankton and smelt—are to a large extent pelagic.

Just how important and productive the great expanse of deep water in Sebago is for salmon is still a question. Our gill nets caught salmon at depths of about 35 to 60 feet, but none in two sets at 70 to 85 feet. Local fishermen reported that few if any fish (of any kind) are caught at depths greater than 100 to 125 feet, and most fish are caught at considerably less than 100 feet. The great expanse of water in Sebago over 150 feet deep is probably of little direct importance to the salmon population.

The fish stocked in Sebago Lake during the past five years by the Fish and Game Department are as follows:

5,000	two- to three-inch Land-locked Salmon
195,100	two- to four-inch Land-locked Salmon
173,000	four- to six-inch Land-locked Salmon
86,476	"mature" (over 6 inches) Land-locked Salmon
60,500	four- to six-inch Brook Trout
400	"mature" Brook Trout
9,700	4-year-old Brook Trout
52	mature Small-mouthed Bass

Recommendations: Sebago Lake is deserving of very intensive stocking of Land-locked Salmon in view of several facts: it is excellent salmon water with a good food supply; it is heavily fished; and its best natural spawning stream, the Crooked River, is considerably altered and mostly inaccessible because of dams. A consideration of the extent to which the state should stock the lake introduces a complex problem.

From the present survey it was calculated that the lake could be stocked on the basis of having over 25,000 acres of productive salmon water. This figure might be reduced to 17,000 by subtracting the 8,000 acres of water in the center of the main part of the lake which is over 150 feet deep (the justification for this is questionable). The lake is heavily fished; it was given a food grade of I for salmon; and natural spawning facilities are poor. If the trout and salmon stocking table is applied in the same manner as it has been to the other trout and salmon lakes, the lake could be stocked at the rate of 30 six-inch fish per acre or about 500,000 six-inch fish annually. This would be many times the numbers of fish that are stocked in all of the other 30 lakes combined. Stocking at this rate at the present time does not seem at all justifiable, because it would be far out of proportion to the present distribution of fishing interests and to the local hatchery output for this section of Maine in general. However, the results of the present survey seem to indicate that Sebago Lake has an enormous carrying capacity, and there is much logic in favor of planting more fish in Sebago at the expense of some of the smaller lakes which have not produced as well in proportion to the numbers of fish stocked. It is therefore recommended that salmon stocking in Sebago be increased to about 200,000 six-inch fish annually; the increase is recommended with the belief that Sebago is by far the best salmon water in this section of the state.

Further restrictions on taking of smelts from Sebago do not seem necessary at the present time, but if any marked decrease in the smelt population takes place in the future, the smelt should be given complete protection in the interest of maintaining salmon fishing.

PEABODY POND, P. 302

(See map, Fig. 9)

Cumberland County | *Bridgton, Naples, Sebago* Townships

Area 735 acres | *Elevation* 460+ ft. | *Maximum depth* 64 ft.

Peabody Pond was examined on July 6 to 9. The maximum depth of 64 feet was found in the extreme southwestern corner of the pond. It was calculated from the sounding data that the pond is divided according to depth as follows:

166 acres of bottom area between 0 and 20 feet deep
384 acres of bottom area between 20 and 45 feet deep
185 acres of bottom area between 45 and 64 feet deep

Water analyses were made at three stations on July 8 at which time the water at the surface was found to be fairly cold and above 70° F. only down to a depth of about 6 feet. The upper limit of the thermocline, however, existed at about 18 feet. Oxygen was found to be sufficient for trout and salmon at all depths on this date, although there had been some reduction of oxygen in the deep water. With regards to pH, the pond was found to be about average for lakes and ponds of this size in southern Maine, with pH values of 6.8 at the surface and pH values considerably into the acid range (5.9) at the bottom at two stations. On the basis of water analyses, it was estimated that during the late summer the warm water would extend down to a depth of about 20 feet and that oxygen would remain sufficient for trout and salmon at all depths. On the basis of this estimate, the pond is divided according to its suitability for trout and salmon during late summer as follows:

Upper warm water, surface to 20 feet, no trout: 13,007 acre feet (56%) of water, 166 acres (23%) of bottom area

Middle layer, 20 to 64 feet, suitable for trout and salmon: 10,155 acre feet (44%) of water, 569 acres (77%) of bottom area

Lower layer, oxygen deficient, no trout: None

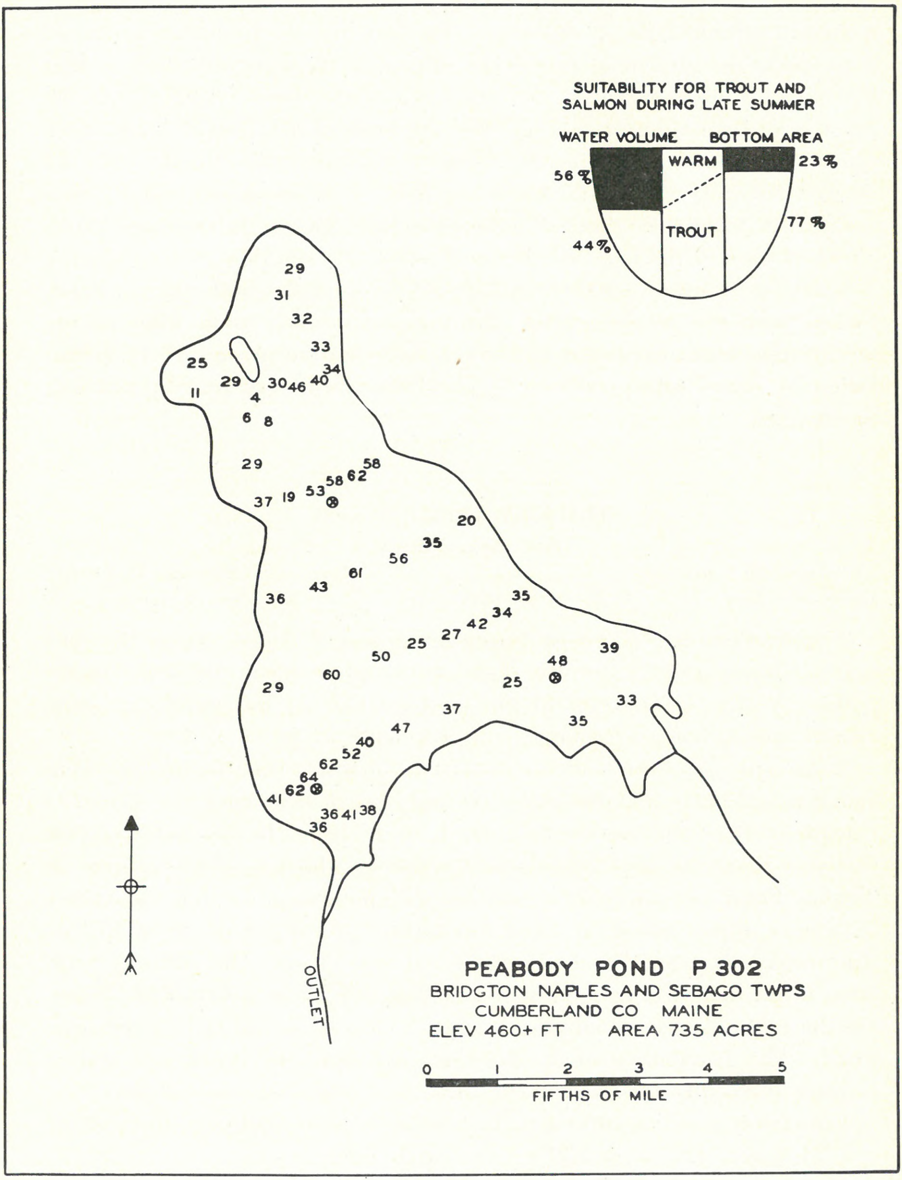
From the standpoint of depth, temperature and oxygen, Peabody Pond is very good trout and salmon water.

Plankton was found to be quite rare in the pond but smelts were rated in the warden reports as being common. On the strength of this scarcity of plankton and the general scarcity of forage fishes in the pond, it was given a food grade of III for salmon.

The game fishes known to be present in the pond were Yellow Perch, Pickerel, Horned Pout, Brook Trout and Land-locked Salmon. None of the warm-water game fishes were abundant, and the pond was rated as having a competition factor of 7.

According to records of the Fish and Game Department, the only fish which have been planted in Peabody Pond during the past 5 years were

FIG. 9


SUITABILITY FOR TROUT AND
SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
56 %
44 %
23 %
77 %
OUTLET
PEABODY POND P 302
BRIDGTON NAPLES AND SEBAGO TWPS
CUMBERLAND CO MAINE
ELEV 460+ FT AREA 735 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

10,000 four- to six-inch Brook Trout in 1933-34 and 3,000 "mature" Brook Trout in 1937-38.

Recommendations: Peabody Pond is one of the best of the smaller trout and salmon lakes in this area. The fact that the pond has produced a considerable number of very large salmon in the past and the fact that the Smelt is still present in the pond are pretty good evidence that the pond is still suitable for salmon. On the basis of a III food grade, poor spawning grounds, and medium fishing intensity, the pond could be stocked annually with 9,100 fingerling fish. It is recommended that this amount of stocking be divided up between Land-locked Salmon and Brook Trout in view of the fact that the pond is equally suitable to both species. A yearly stocking of 4,500 six-inch Brook Trout and 4,600 six-inch Land-locked Salmon is recommended. Stock no warm-water game fishes of any kind. Also attempts should be made to increase the present Smelt population by completely protecting those which are present and by planting Smelt eggs.

TRICKEY POND, P. 303

(See map, Fig. 10)

Cumberland County — *Naples,* Township

Area 311 acres — *Elevation* 360+ ft. — *Maximum depth* 57 ft.

Trickey Pond was surveyed during the period of August 15 to 18. The maximum depth of 57 feet was found at two places near the center of the pond. A large proportion of the southern half of the pond was quite remarkable in being of a fairly uniform depth of 50 to 57 feet.

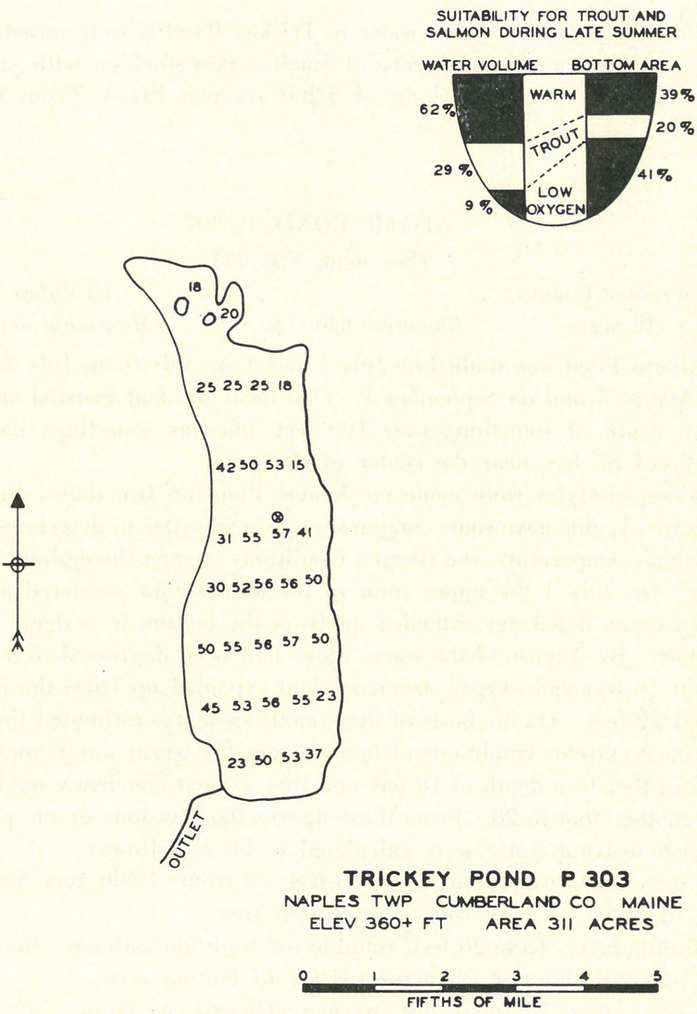
Water analyses were made on August 16 at which time warm water was found to extend to a depth of 26 feet and oxygen deficiency was found to extend up from the bottom to a depth of 47 feet. It was believed that this was about the most extreme of conditions which would ever exist in Trickey Pond under normal conditions with the exception that the oxygen deficiency might extend up a few feet farther to a depth of about 45 feet. The water in Trickey Pond was white and very clear. The pH was somewhat lower than average: 6.7 at the surface and 5.8 at a depth of 50 feet. On the basis of water analyses, Trickey Pond can be called a good trout pond. The distribution of the different regions of the pond with respect to their suitability for trout during the late summer are as follows:

Upper warm water, surface to 26 feet, no trout: 6,448 acre feet (62%) of water, 121 acres (39%) of bottom area

Middle layer, 26 to 45 feet, suitable for trout and salmon: 2,989 acre feet (29%) of water, 63 acres (20%) of bottom area

Lower layer, 45 to 57 feet, oxygen deficient, no trout: 902 acre feet (9%) of water, 127 acres (41%) of bottom area

FIG. 10


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
62 %
29 %
9 %
39 %
20 %
41 %
18
20
25 25 25 18
42 50 53 15
31 55 57 41
30 52 56 56 50
50 55 56 57 50
45 53 56 55 23
23 50 53 37
OUTLET
TRICKEY POND P 303
NAPLES TWP CUMBERLAND CO MAINE
ELEV 360+ FT AREA 311 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

The present game fish population of the pond is rather meagre, and includes the Yellow Perch, Pickerel and Horned Pout among the warm-water game fishes. The warden reports indicate that Brook Trout might be present.

The pond was stocked with 5,000 four- to six-inch Brook Trout in 1933 and 5,000 "mature" Brook Trout in 1934.

Recommendations: The water in Trickey Pond is well suited to Brook Trout. The scarcity or absence of Smelt makes stocking with salmon undesirable. A yearly stocking of 5,200 six-inch Brook Trout is recommended.

ADAMS POND, P. 307

(See map, Fig. 11)

Cumberland County — *Bridgton* Township

Area 112 acres — *Elevation* 640+ ft. — *Maximum depth* 51 ft.

Adams Pond was studied on July 1 and 2, on July 6, on July 21 and 22, on August 4 and on September 1. One local resident insisted on a maximum depth of something over 100 feet, but our soundings indicated a depth of 51 feet near the center of the pond.

Water analyses were made on Adams Pond on two dates, July 1 and August 14; this gave some comparative data in order to determine the rate at which temperature and oxygen conditions change throughout the summer. On July 1 the upper limit of the thermocline occurred at 12 feet and oxygen deficiency extended up from the bottom to a depth of about 30 feet. By August 14 the warm water had been depressed to a depth of about 16 feet and oxygen deficiency had extended up from the bottom to about 29 feet. On the basis of these analyses it was estimated that during the most extreme conditions of late summer the warm water might extend still farther to a depth of 18 feet and that oxygen deficiency might extend up another foot to 28. From these figures the divisions of the pond with respect to trout water were calculated to be as follows:

Upper warm water, surface to 18 feet, no trout: 1,596 acre feet (69%) of water, 45 acres (40%) of bottom area

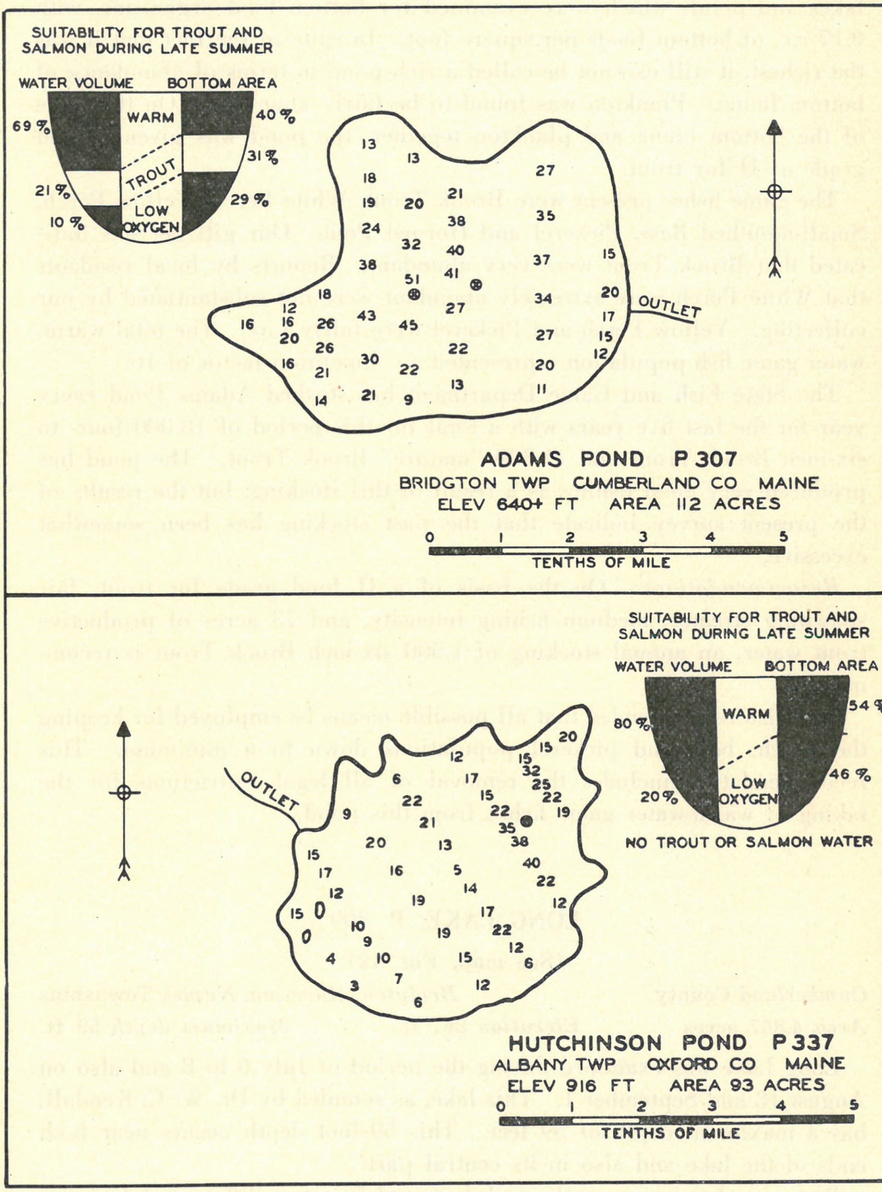
Middle layer, 18 to 28 feet, suitable for trout and salmon: 483 acre feet (21%) of water, 35 acres (31%) of bottom area

Lower layer, 28 to 51 feet, oxygen deficient, no trout: 242 acre feet (10%) of water, 32 acres (29%) of bottom area

On the basis of these figures, Adams Pond can be classified as good trout water from the standpoint of temperature and oxygen.

During the studies on bottom food organisms it was found that Adams Pond has mud bottom throughout practically the entire area of the pond

FIG 11


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
69 %
21 %
10 %
40 %
31 %
29 %
OUTLET
ADAMS POND P 307
BRIDGTON TWP CUMBERLAND CO MAINE
ELEV 640+ FT AREA 112 ACRES
0 1 2 3 4 5
TENTHS OF MILE
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
LOW OXYGEN
80 %
20 %
54 %
46 %
NO TROUT OR SALMON WATER
OUTLET
HUTCHINSON POND P 337
ALBANY TWP OXFORD CO MAINE
ELEV 916 FT AREA 93 ACRES
0 1 2 3 4 5
TENTHS OF MILE

below a depth of 12 feet. The bottom in the shallower water is a mixture of mud and sand. Adams Pond was found to be the richest of the four lakes and ponds which were examined for bottom food organisms, with 0.17 c.c. of bottom foods per square foot. In spite of the fact that it was the richest, it still can not be called a rich pond in terms of abundance of bottom fauna. Plankton was found to be fairly abundant. On the basis of the bottom fauna and plankton together, the pond was given a food grade of II for trout.

The game fishes present were Brook Trout, White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Our gill net sets indicated that Brook Trout were very abundant. Reports by local residents that White Perch were extremely abundant were not substantiated by our collecting. Yellow Perch and Pickerel were fairly rare. The total warm-water game fish population represented a competition factor of 10.

The State Fish and Game Department has stocked Adams Pond every year for the last five years with a total for this period of 18,000 four- to six-inch Brook Trout and 11,300 "mature" Brook Trout. The pond has produced very good fishing as a result of this stocking, but the results of the present survey indicate that the past stocking has been somewhat excessive.

Recommendations: On the basis of a II food grade for trout, fair spawning streams, medium fishing intensity, and 73 acres of productive trout water, an annual stocking of 1,500 six-inch Brook Trout is recommended.

It is also recommended that all possible means be employed for keeping the perch, bass and pickerel populations down to a minimum. This recommendation includes the removal of all legal restrictions for the taking of warm-water game fishes from this pond.

LONG LAKE, P. 309

(See map, Fig. 12)

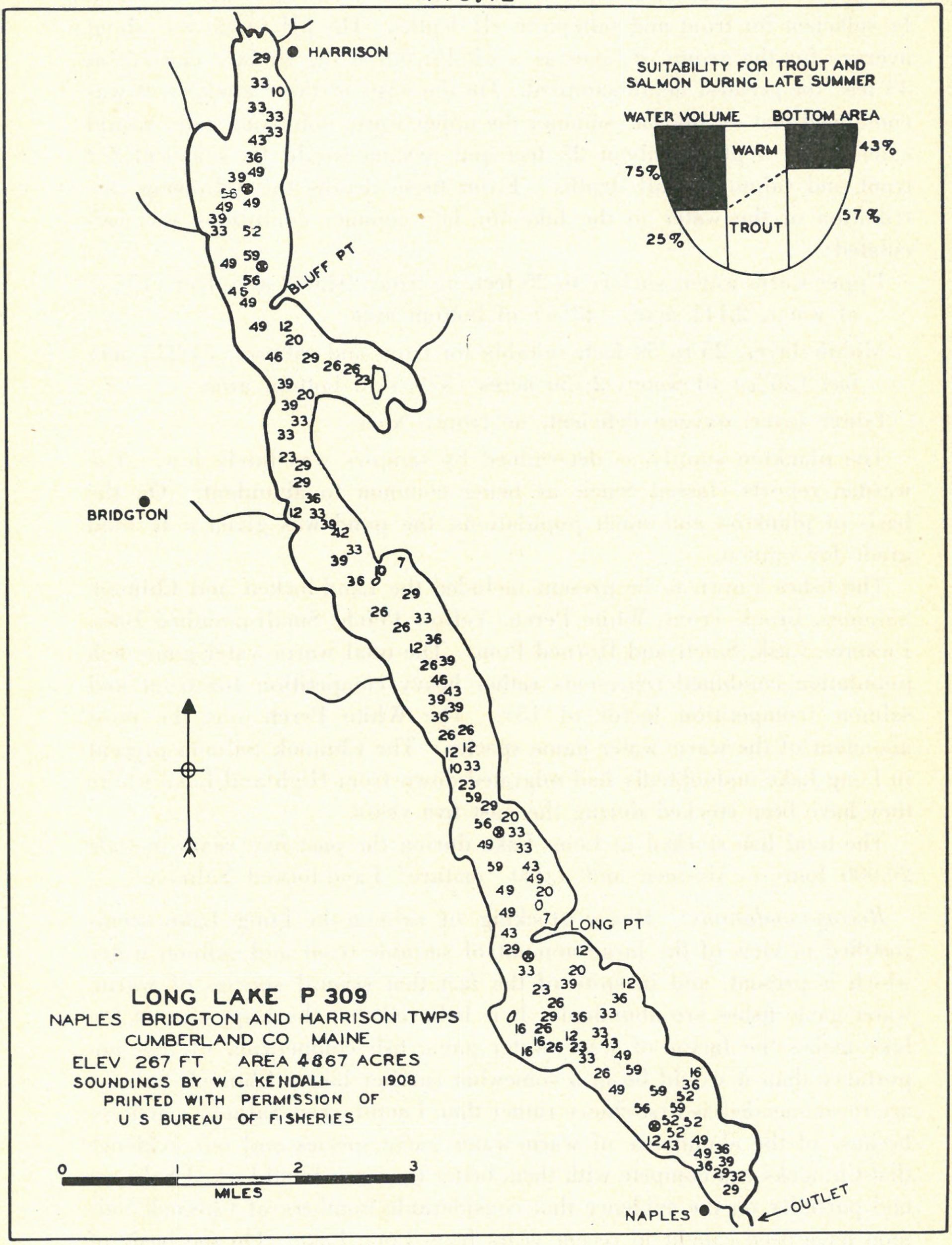
Cumberland County — *Bridgton, Harrison, Naples* Townships

Area 4,867 acres — *Elevation* 267 ft. — *Maximum depth* 59 ft.

Long Lake was examined during the period of July 6 to 8 and also on August 18 and September 1. This lake, as sounded by Dr. W. C. Kendall, has a maximum depth of 59 feet. This 59-foot depth occurs near both ends of the lake and also in its central part.

Water analyses were made on July 6 and 7 at five different stations on the lake. The vertical distribution of temperature at two of these stations was found to be quite unique, but was readily attributable to weather conditions of high wind and considerable wave action. The most reliable

FIG. 12


HARRISON
BLUFF PT
BRIDGTON
LONG PT
NAPLES
OUTLET
SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
75%
25%
43%
57%
LONG LAKE P 309
NAPLES BRIDGTON AND HARRISON TWPS
CUMBERLAND CO MAINE
ELEV 267 FT AREA 4867 ACRES
SOUNDINGS BY W C KENDALL 1908
PRINTED WITH PERMISSION OF
U S BUREAU OF FISHERIES
0
1
2
3
MILES

set of temperatures, taken on July 7, indicated that the upper region of the thermocline was at a depth of about 20 feet. Oxygen was found to be sufficient for trout and salmon at all depths. The pH range was about average for the group of lakes as a whole: 6.8 at the surface and 6.2 at 43 feet, the greatest depth sampled. On the basis of these analyses it was concluded that during late summer the upper warm non-trout water would extend to a depth of about 25 feet and oxygen would be sufficient for trout and salmon at all depths. From these depths the following distribution of the water in the lake for late summer conditions was calculated:

Upper warm water, surface to 25 feet, no trout: 94,042 acre feet (75%) of water, 2,111 acres (43%) of bottom area

Middle layer, 25 to 59 feet, suitable for trout and salmon: 31,235 acre feet (25%) of water, 2,756 acres (57%) of bottom area

Lower layer, oxygen deficient, no trout: None

The plankton supply as determined by samples was fairly low. The warden reports classed Smelt as being common to abundant. On the basis of plankton and smelt populations, the pond was given a II food grade for salmon.

The fishes known to be present included the Land-locked and Chinook Salmons, Brook Trout, White Perch, Yellow Perch, Small-mouthed Bass, Pickerel, Cusk, Smelt and Horned Pout. The total warm-water game fish population combined represents rather heavy competition for trout and salmon (competition factor of 15). The White Perch was the most abundant of the warm-water game species. The Chinook Salmon present in Long Lake undoubtedly had migrated down from Highland Lake where they have been stocked during the past five years.

The total fish stocked in Long Lake during the past five years include 20,000 four- to six-inch and 4,000 "mature" Land-locked Salmon.

Recommendations: Heavy stocking of salmon in Long Lake seems justified in view of the large amount of suitable trout and salmon water which is present, and in spite of the fact that several species of warm-water game fishes are abundant. It is believed that the large size of the lake makes the factor of warm-water game fish competition of less importance than it would be in a somewhat smaller lake. Chinook Salmon are recommended as first choice rather than Land-locked Salmon, partially because of the abundance of warm-water game species and our evidence that Chinooks can compete with them better than can Land-locked Salmon, and partially on the evidence that considerable numbers of Chinook Salmon have been caught in recent years from Long Lake. On the basis of a II food grade for salmon, heavy fishing intensity, and 3,811 acres of salmon producing water, a yearly stocking of 30,800 six-inch Chinook

Salmon is recommended. If these fish are not available, the same number of Land-locked Salmon is recommended.

Taking of Smelt from Long Lake and its tributaries should be prohibited at all seasons, in the interest of salmon fishing.

WOOD POND, P. 313

(See map, Fig. 13)

Cumberland County — *Bridgton* Township

Area 442 acres — *Elevation* 456 ft. — *Maximum depth* 29 ft.

Wood Pond was examined on June 22 to 25, and on August 3 and 23. Soundings revealed the pond to be uniformly very shallow as compared to its size, with a maximum depth of 29 feet near the center of the pond.

Water analyses on June 23 and August 3 gave information on the change of temperature and oxygen conditions in the pond during the summer. The most important of these changes was the fact that the warm water was depressed from a depth of 10 feet on June 23 to a depth of about 16 feet on August 3, and the oxygen deficiency did not exist, from the standpoint of trout and salmon, on June 23 but extended from the bottom up to a depth of about 17 feet on August 3. In general, the water in Wood Pond was very acid; 6.4 to 6.7 at the surface and an extreme low of 5.5 at 24 feet on August 3. These water analyses indicated that during the most critical late summer conditions there would be absolutely no trout or salmon water in Wood Pond, with the warm water extending down to a depth of 17 feet and oxygen-deficient water extending up from the bottom to this same depth of 17 feet:

Upper warm water, surface to 17 feet, no trout: 5,927 acre feet (80%) of water, 179 acres (41%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 17 to 29 feet, oxygen deficient, no trout; 1,509 acre feet (20%) of water, 263 acres (59%) of bottom area

Soundings revealed the bottom of Wood Pond to be almost entirely mud in deep water which partially explains the large amount of organic decomposition in the deep part of the lake.

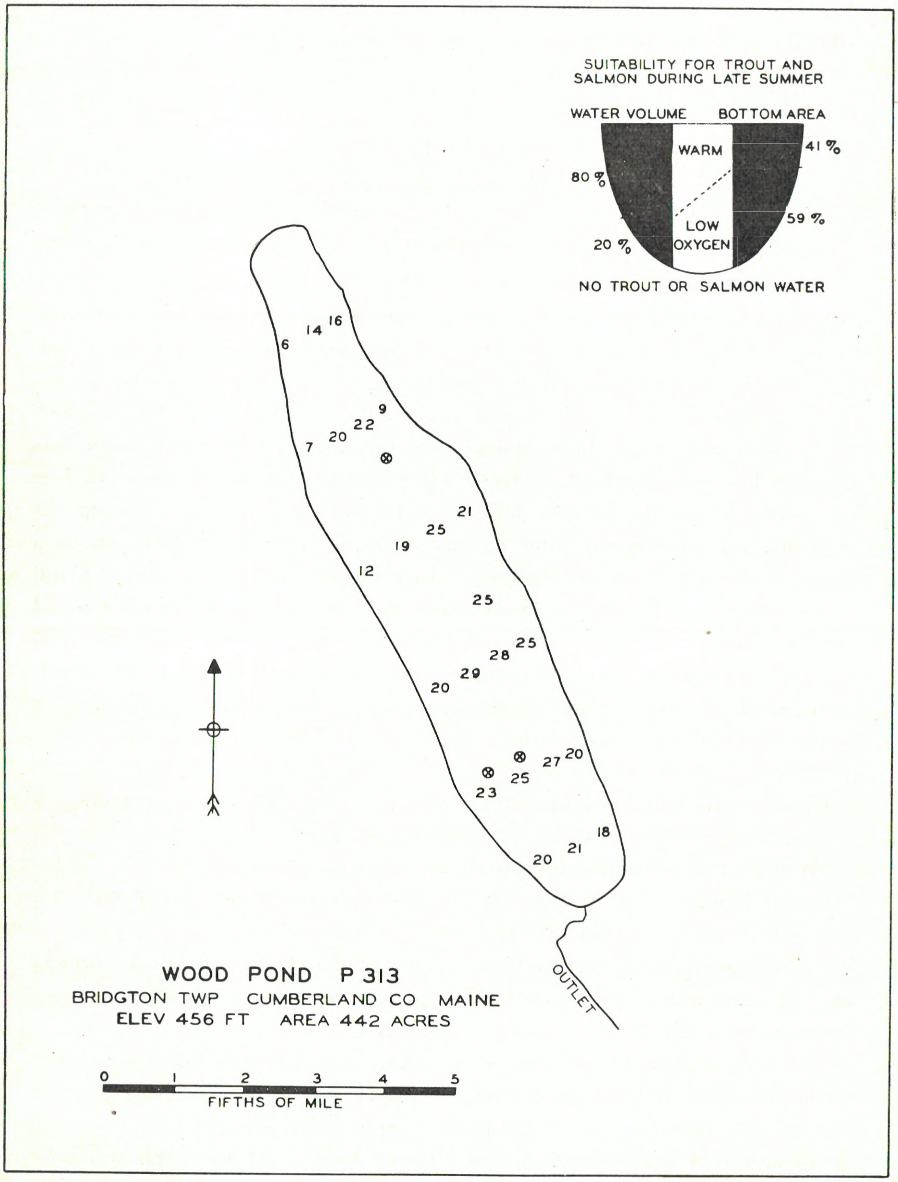
Plankton in Wood Pond was quite abundant but forage fishes were only fairly common, and the pond was given a II food grade for bass.

The game fishes known to be present were White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. White Perch were the most abundant of these game species and bass were fairly common.

Wood Pond was stocked with 15,000 "mature" Brown Trout during the fiscal year of 1937-38. This was the only stocking for the past five years.

Recommendations: Wood Pond has absolutely no trout water at all,

FIG. 13


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
LOW OXYGEN
80 %
20 %
41 %
59 %
NO TROUT OR SALMON WATER
OUTLET
WOOD POND P 313
BRIDGTON TWP CUMBERLAND CO MAINE
ELEV 456 FT AREA 442 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

according to the standards set for the present survey. It might be argued in support of the policy of stocking Brown Trout that this species can tolerate water much above 70° F. for a considerable period. However, during extremely hot weather, Brown Trout would undoubtedly have to stand water in the high 70's, or else water with very low oxygen, for periods of several weeks if they were to remain in Wood Pond over a period of several years. In view of the present populations of White Perch, Small-mouthed Bass and Pickerel, it is very improbable that any appreciable numbers of stocked Brown Trout would survive in Wood Pond for very long. It is therefore recommended that no more plantings of any of the trouts or salmons be made in Wood Pond.

This pond is really best suited for development of Small-mouthed Bass fishing. It now has a fair population of bass, excellent spawning grounds for this species and a fair food supply. Stock yearly 1,700 Small-mouthed Bass fingerlings. Close pond to all bass fishing at least until June 21, and preferably until July 1. Stock the pond with 1,000 adult Golden Shiners as a breeding stock to establish this minnow as a food supply for the bass.

HIGHLAND LAKE, P. 314

(See map, Fig. 14)

Cumberland County — *Bridgton* Township

Area 1,401 acres — *Elevation* 426 ft. — *Maximum depth* 50 ft.

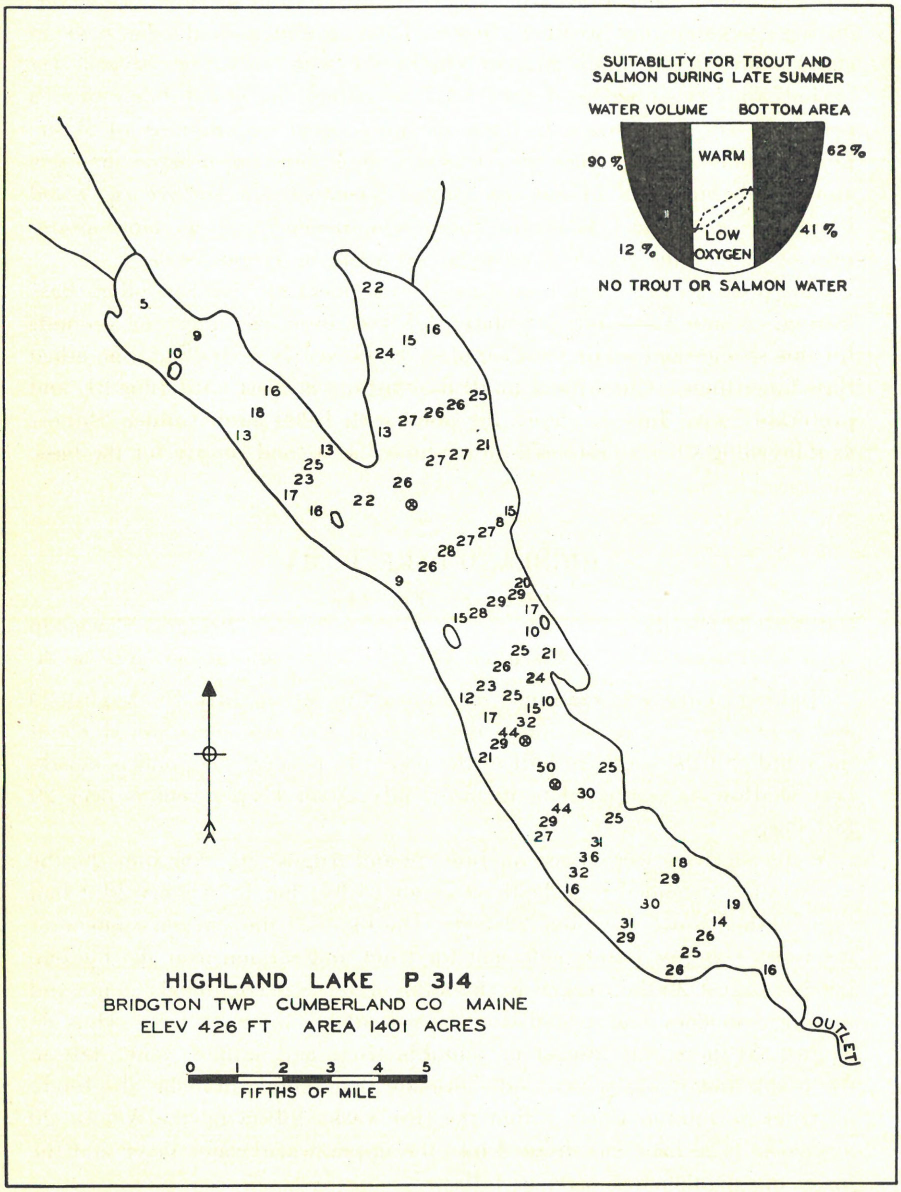
Highland Lake was examined on June 28 to 30, on July 15, August 20 and September 2. A maximum depth of 50 feet was encountered about the middle of the southern half of the lake. In general the pond is mostly very shallow as compared to its size; only about 11 per cent is over 29 feet deep.

Water analyses were made on June 29 and August 20. On June 29, the warm water extended to a depth of about 13 feet but by August 20 it had been pushed down to about 22 feet. On June 29 the oxygen content of the water was just barely sufficient for trout and salmon near the bottom, but by August 20 the oxygen in this deep water was completely gone, and oxygen deficiency had extended up to a depth of about 24 feet. Thus on August 20 there was almost no suitable trout and salmon water left in the pond, and it was a very safe estimate that there would be absolutely no trout or salmon water within the two weeks following the August 20 analyses. The lake was divided into the upper warm-water layer and the lower oxygen-deficient layer as follows:

Upper warm water, surface to 25 feet, no trout or salmon: 23,497 acre feet (90%) of water, 867 acres (62%) of bottom area

Middle layer, suitable for trout and salmon: None

FIG 14


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
90 %
62 %
LOW OXYGEN
12 %
41 %
NO TROUT OR SALMON WATER
OUTLET
HIGHLAND LAKE P 314
BRIDGTON TWP CUMBERLAND CO MAINE
ELEV 426 FT AREA 1401 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

Lower layer, 24 to 50 feet, oxygen deficient, no trout or salmon: 3,196 acre feet (12%) of water, 572 acres (41%) of bottom area

The plankton supply of Highland Lake was found to be fairly good and warden reports indicated the minnow population to be common. The lake was given a II food grade for bass.

The pond is known to contain White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Small-mouthed Bass were fairly common but the lake should have been supporting a much greater population of young bass.

Highland Lake has been stocked quite heavily during the past five years with the following: 20,000 four- to six-inch Brook Trout, 5,000 "mature" Brook Trout, 34,500 four- to six-inch Chinook Salmon, 20,000 "mature" Chinook Salmon, and 50 adult bass; 4,500 of the Chinooks were stocked in 1933-34 and the remainder were stocked during 1936 to 1938. In spite of this heavy stocking with trout and salmon for the past five years, no trout or salmon were taken in 36½ hours of fishing with our 150- and 375-foot gill nets. Local residents reported that during the spring of 1939 considerable numbers of Chinooks were caught in Long Lake, but no Chinooks were caught (to their knowledge) in Highland Lake. Presumably those Chinooks caught in Long Lake were the fish which had been planted in Highland. There seems to be absolutely no doubt that trout and salmon have not become established in Highland Lake, and the chief reason is undoubtedly the fact that the water is not at all suitable to them. There is no reason to believe that Highland Lake would ever produce any amount of trout or salmon fishing, even if stocking were continued for many years.

Recommendations: Stock no more trout or salmon of any kind. The lake is best suited for the development of the Small-mouthed Bass fishing. Stock yearly 11,000 three-inch Small-mouthed Bass fingerlings. Close the lake to bass fishing at least until June 21 and preferably until July 1 in order to protect the adult bass on the spawning grounds.

STEARNS POND, P. 315

(See map, Fig. 15)

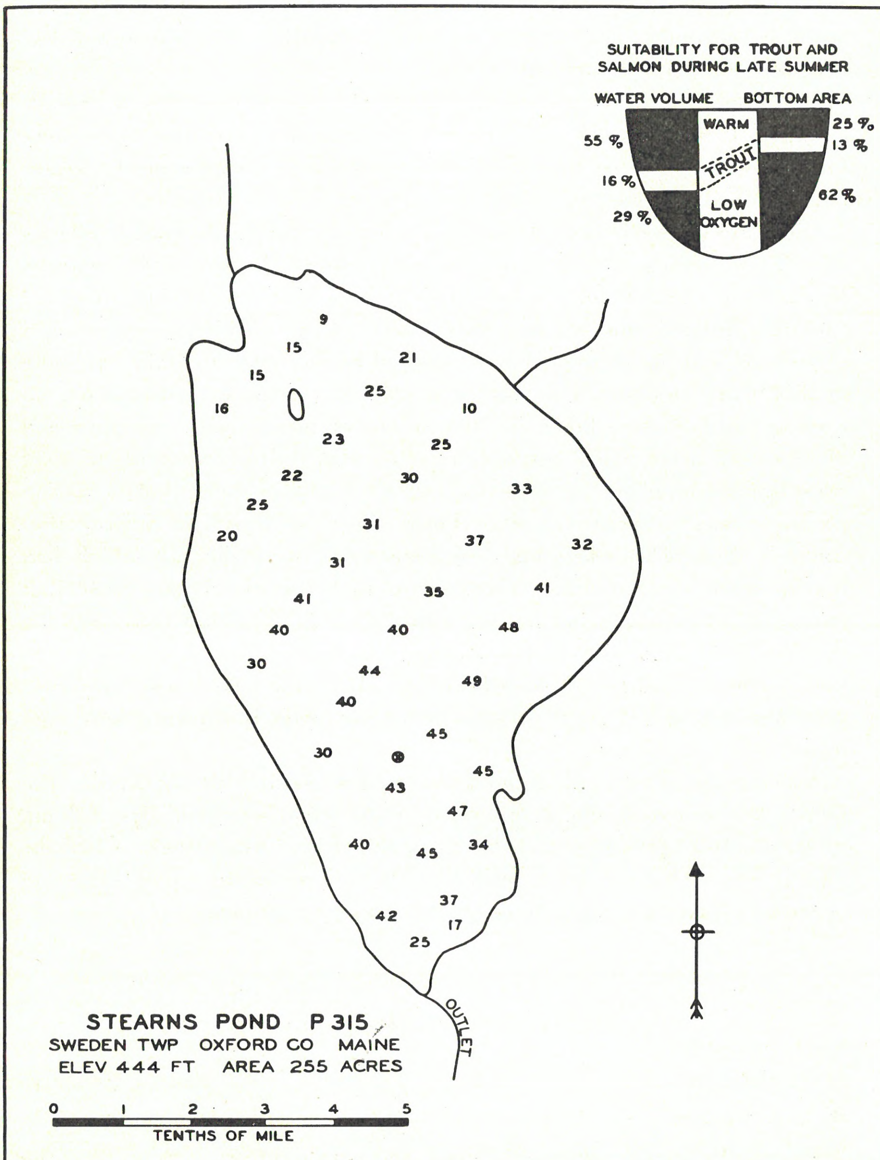
Oxford County — *Sweden* Township

Area 255 acres — *Elevation* 444 ft. — *Maximum depth* 47 ft.

Stearns Pond was examined during the period of July 25 to 27. The maximum depth of 47 feet was found in the southern end of the pond.

Water analyses on July 27 revealed trout water between depths of 13 and 28 feet. From these tests it was estimated that by the end of August, suitable trout water would be found only between 16 and 22 feet, thus

FIG. 15


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
55 %
16 %
29 %
25 %
13 %
62 %
9
15
15
16
21
25
10
23
25
22
30
33
25
20
31
37
32
31
35
41
41
40
40
48
30
44
49
40
45
30
45
43
47
40
45
34
37
42
17
25
OUTLET
STEARNS POND P 315
SWEDEN TWP OXFORD CO MAINE
ELEV 444 FT AREA 255 ACRES
0 1 2 3 4 5
TENTHS OF MILE

dividing the pond into the following three parts with respect to suitable trout water:

Upper warm water, surface to 16 feet, no trout: 3,557 acre feet (55%) of water, 64 acres (25%) of bottom area

Middle layer, 16 to 22 feet, suitable for trout and salmon: 1,042 acre feet (16%) of water, 34 acres (13%) of bottom area

Lower layer, 22 to 47 feet, oxygen deficient, no trout: 1,929 acre feet (29%) of water, 157 acres (62%) of bottom area

Under the most adverse conditions of late summer, Stearns Pond has some trout water, but the amount is so small in proportion to the total amount of water in the pond that it can be classed, at best, as only a very poor trout pond.

The plankton population of the pond and the forage fish supply were found to be very scarce. The pond was given a food grade of III for bass and other warm-water fishes.

The game fishes present were White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Smelts were present but were not considered to be of any particular significance as a salmon or trout food supply because the water supply of the pond is not particularly adaptable to these cold-water species. A recent warden census of bass waters in this state accredited Stearns Pond with furnishing good fishing for Large-mouthed Bass. No evidence of this species being present was found during the survey.

No fish have been stocked in Stearns Pond during the past 5 years, according to records of the Fish and Game Department.

Recommendations: No stocking of trout or salmon in Stearns Pond because of the relatively very small amount of water suitable for these cold-water fishes; rather, concentrate efforts on improving the lake for bass fishing as it appears to be well adapted to this species. Stock annually 500 three-inch Small-mouthed Bass fingerlings.

MOOSE POND, P. 319

(See map, Fig. 16)

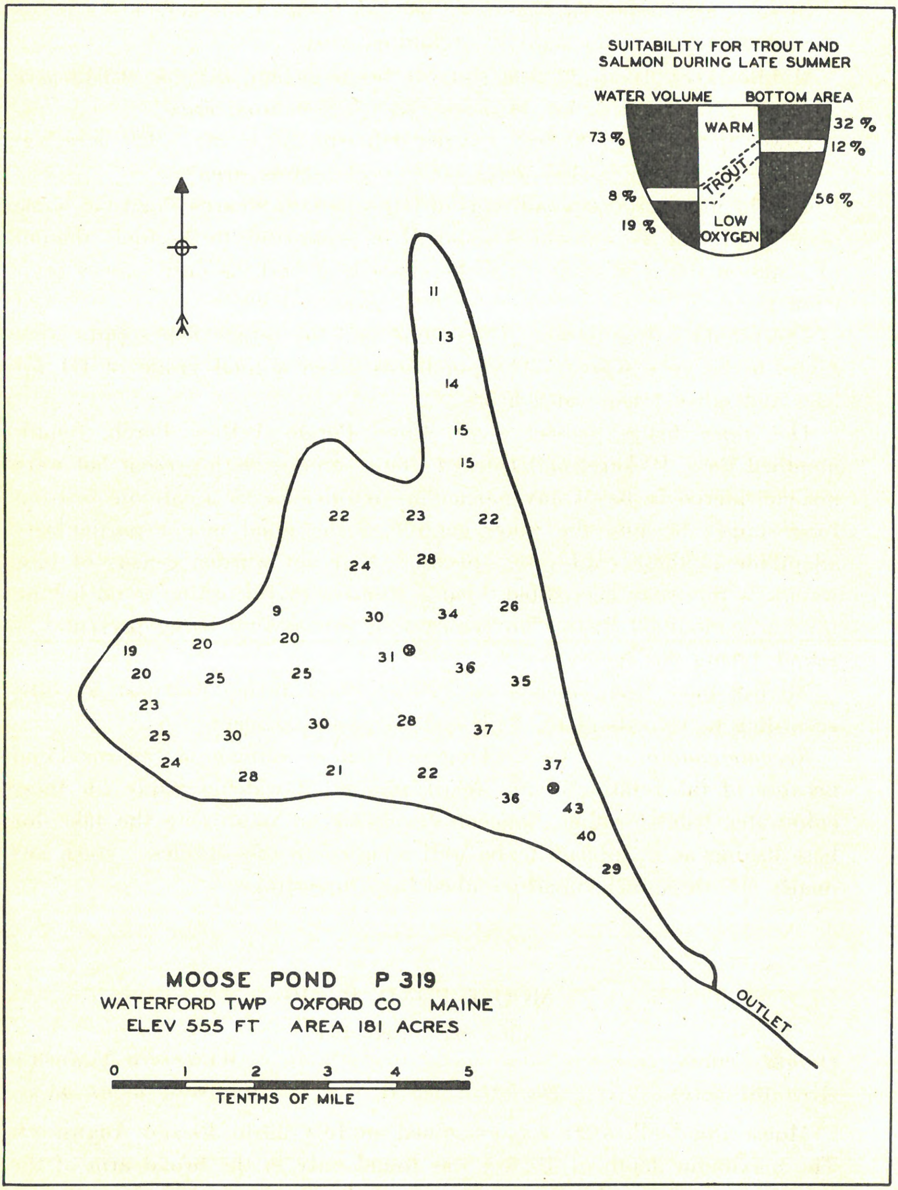
Oxford County — *Waterford* Township

Area 181 acres — *Elevation* 555 ft. — *Maximum depth* 43 ft.

Moose Pond (P. 319) was examined on July 28 to 30 and August 23. The maximum depth of 43 feet was found only in the broad arm of the bay at the outlet end. Practically all of the pond was less than 40 feet deep.

Twe sets of water analyses on July 29 at two different positions on the pond gave almost identical results with respect to vertical distribution of

FIG. 16


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
73 %
8 %
19 %
32 %
12 %
56 %
11
13
14
15
15
22
23
22
24
28
9
30
34
26
19
20
20
31
36
35
20
25
25
23
30
28
37
25
30
24
28
21
22
37
36
43
40
29
OUTLET
MOOSE POND P 319
WATERFORD TWP OXFORD CO MAINE
ELEV 555 FT AREA 181 ACRES
0
1
2
3
4
5
TENTHS OF MILE

temperature and pH. The warm water extended to a depth of 17 feet and oxygen deficiency extended up from the bottom to a depth of 24 feet, from which it was estimated that the critical depths, by the end of August, would be 19 and 22 feet. This would leave the following distribution of the water in the pond with respect to its suitability for trout and salmon:

Upper warm water, surface to 19 feet, no trout: 2,869 acre feet (73%) of water, 58 acres (32%) of bottom area

Middle layer, 19 to 22 feet, suitable for trout and salmon: 335 acre feet (8%) of water, 22 acres (12%) of bottom area

Lower layer, 22 to 43 feet, oxygen deficient, no trout: 741 acre feet (19%) of water, 101 acres (56%) of bottom area

Moose Pond, like Stearns Pond, has a small amount of good trout water present under the most adverse conditions, but the amount of this water is so small as compared to the amount of water in the entire lake that stocking with trout or salmon would be expected to give very poor results.

The plankton population of Moose Pond was quite abundant and considerably better than the supply in Stearns Pond. Moose Pond was given a food grade of II for bass.

The fish known to be present were the White and Yellow Perches, Pickerel and Horned Pout. Small-mouthed Bass were not known to be present but the pond appeared to be well adapted to this species. White Perch were found to be abundant and very small in size; apparently the pond is over-stocked with this species.

Moose Pond has not been stocked by the Fish and Game Department during the past 5 years.

Recommendations: No stocking of trout or salmon of any kind. Rather, develop the lake for bass fishing and stock 700 three-inch Small-mouthed Bass fingerlings yearly.

BEAR POND, P. 321

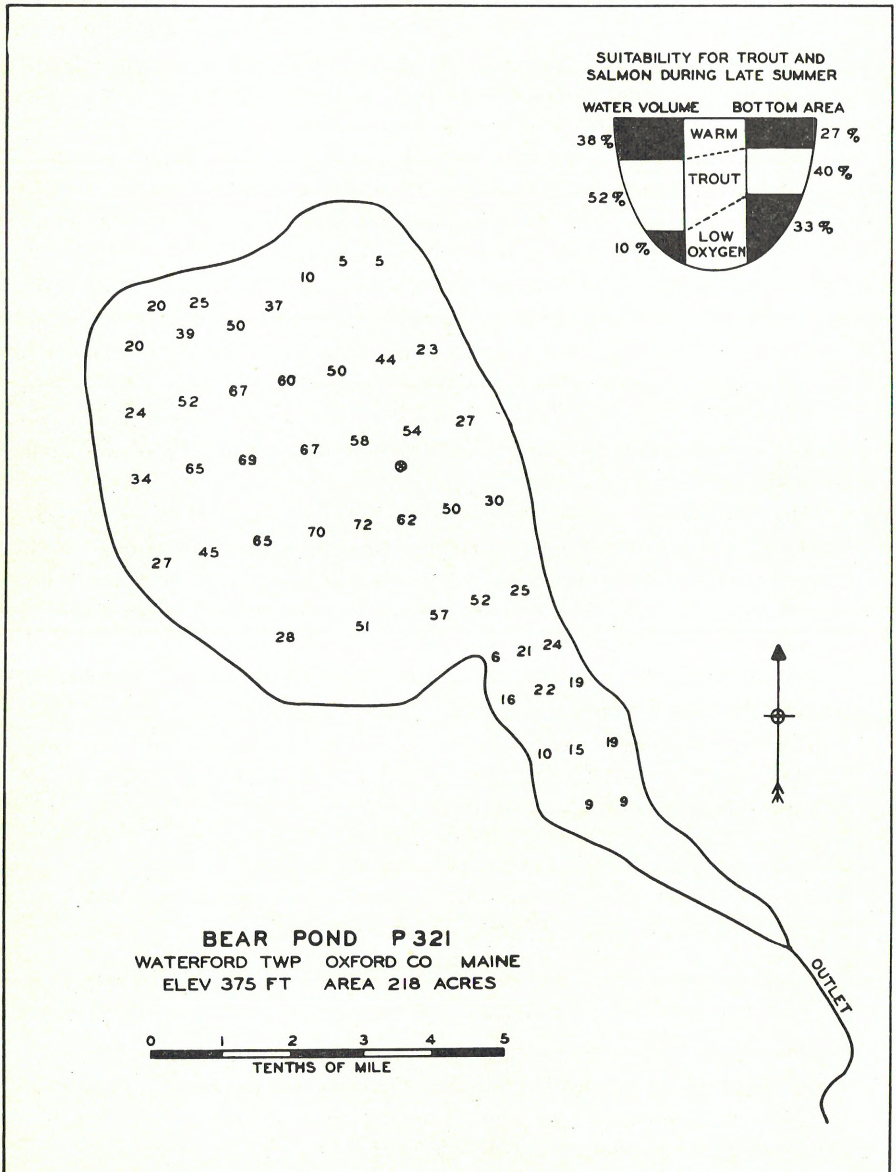
(See map, Fig. 17)

Oxford County		*Waterford* Township
Area 218 acres	*Elevation* 375 ft.	*Maximum depth* 72 ft.

Bear Pond was examined on July 28 and 29 and August 23. The maximum depth of 72 feet was found near the center of the Pond. Bear Pond is quite exceptional for its size in having such a large amount of relatively deep water, that is, between 50 and 70 feet.

Water analyses on July 28 indicated that the water in Bear Pond is excellent for trout and salmon. Warm (above 70° F.) water extended to a depth of 12 feet and oxygen was sufficient for trout and salmon at a depth of 58 feet. From these critical depths it was estimated that by the

FIG. 17


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
38 %
52 %
10 %
27 %
40 %
33 %
OUTLET
BEAR POND P 321
WATERFORD TWP OXFORD CO MAINE
ELEV 375 FT AREA 218 ACRES
0 1 2 3 4 5
TENTHS OF MILE

end of August the warm water would extend to a depth of 15 feet and the oxygen deficiency would extend up to a depth of 50 feet at the most. This would leave the following divisions of the pond as far as trout water is concerned:

Upper warm water, surface to 15 feet, no trout: 2,810 acre feet (38%) of water, 60 acres (27%) of bottom area

Middle layer, 15 to 50 feet, suitable for trout and salmon: 3,908 acre feet (52%) of water, 87 acres (40%) of bottom area

Lower layer, 50 to 72 feet, oxygen deficient, no trout: 748 acre feet (10%) of water, 71 acres (33%) of bottom area

The food supply of Bear Pond was rated as II for salmon on the basis of a fairly good plankton production and a reported abundance of Smelt.

The game fishes known to be present were the Land-locked Salmon, Brook Trout, White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Bass were probably the most abundant of the warm-water game species. The warm-water game fish competition factor is figured as 12.

A small section of the lower part of Mutiny Brook, which is tributary to the pond, is fairly good spawning water for both salmon and trout, although somewhat small for salmon.

Bear Pond was stocked during 1934-36 with 6,500 four- to six-inch Land-locked Salmon.

Recommendations: Bear Pond is very good salmon water and it also produces excellent fishing for Small-mouthed Bass. The pond is well suited to both species. With respect to stocking, the same arguments hold for Bear Pond as were applied in the case of Kezar Lake. Attempts to improve the fishing for salmon on the one hand and bass on the other would be working at cross purposes, and the effect of greatly improving the lake for the bass fishing would be at the expense of salmon fishing. Therefore, from the standpoint of a stocking policy, sportsmen and local residents in the vicinity of the pond should decide what species of fish they want stocked in the pond, with the understanding that if bass are to be stocked, stocking with salmon should be discontinued.

The following recommendations are made with the idea in mind that since Bear Pond is well adapted to salmon, and since there are so many other ponds equally well suited for bass, the majority of the local fishermen would rather have the lake developed for salmon fishing. On the basis of a II food grade, fair spawning grounds, light fishing intensity, and 152 acres of productive salmon water, a yearly stocking of 2,300 six-inch Land-locked Salmon is recommended. If salmon are stocked in the pond, do not stock any warm-water game fishes, including bass.

If the majority of local residents greatly prefers bass fishing, discontinue stocking the lake with salmon and stock yearly 850 three-inch fingerling Small-mouthed Bass, and close the lake to bass fishing at least until June 21 and preferably until July 1.

KEOKA LAKE, P. 322

(See map, Fig. 18)

Oxford County		*Waterford* Township
Area 467 acres	*Elevation* 492 ft.	*Maximum depth* 42 ft.

Keoka Lake was examined on August 1 to 3 and on August 26. This pond is fairly shallow with a maximum depth of 42 feet near its southern end, but with a rather large per cent of the pond between 30 and 40 feet deep.

Water analyses were made on August 1. The upper temperature limit of good trout water was found at 15 feet and the lower or oxygen limit of trout water was found at 25 feet. From this analysis it was estimated that by the end of August the trout water would be limited to between the depths of 16 and 22 feet, with the following divisions of the pond according to trout water:

Upper warm water, surface to 16 feet, no trout: 6,821 acre feet (56%) of water, 80 acres (17%) of bottom area

Middle layer, 16 to 22 feet, suitable for trout and salmon: 2,140 acre feet (18%) of water, 60 acres (13%) of bottom area

Lower layer, 22 to 42 feet, oxygen deficient, no trout: 3,126 acre feet (26%) of water, 327 acres (70%) of bottom area

On the basis of these analyses Keoka Lake has only a relatively small amount of trout water during late summer, and only slightly more than Stearns and Moose Ponds. A continuation of stocking of this pond with Brook Trout is justifiable largely because of the fact that previous stockings have produced fair trout fishing.

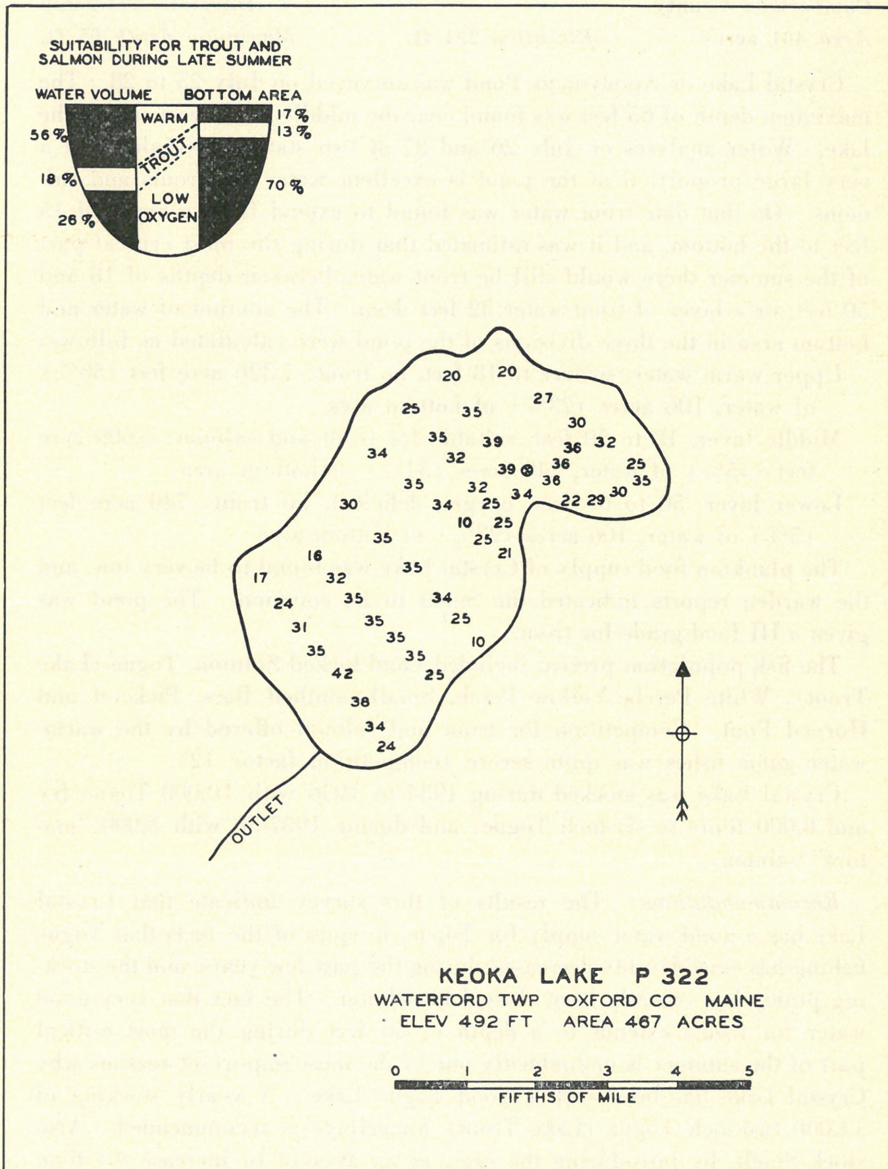
The plankton supply of the lake was found to be fairly abundant and the warden reports indicate that Smelts are present. The pond was given a II food grade for trout.

The present fish population in Keoka Lake includes the Brook Trout, Yellow Perch, Small-mouthed Bass, Pickerel, and Horned Pout. The absence of White Perch contributes somewhat to the fairly low warm-water game fish competition factor (9).

The lake has been stocked during the past five years with 4,000 four- to six-inch and 5,000 "mature" Brook Trout.

Recommendations: Continued stocking of Brook Trout in Keoka seems justified even though the pond is not one of the best of the trout ponds in this area. Stocked with 1,500 six-inch Brook Trout yearly.

FIG. 18


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
56 %
18 %
26 %
17 %
13 %
70 %
OUTLET
KEOKA LAKE P 322
WATERFORD TWP OXFORD CO MAINE
ELEV 492 FT AREA 467 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

CRYSTAL LAKE OR ANONYMOUS POND, P. 324

(See map, Fig. 19)

Cumberland County | *Harrison* Township

Area 461 acres | *Elevation* 294 ft. | *Maximum depth* 65 ft.

Crystal Lake or Anonymous Pond was surveyed on July 25 to 28. The maximum depth of 65 feet was found near the middle of the east side of the lake. Water analyses on July 26 and 27 at two stations revealed that a very large proportion of the pond is excellent water for trouts and salmons. On that date trout water was found to extend from a depth of 15 feet to the bottom, and it was estimated that during the most critical part of the summer there would still be trout water between depths of 18 and 50 feet, or a layer of trout water 32 feet deep. The amount of water and bottom area in the three divisions of the pond were calculated as follows:

Upper warm water, surface to 18 feet, no trout: 7,326 acre feet (50%) of water, 106 acres (23%) of bottom area

Middle layer, 18 to 50 feet, suitable for trout and salmon: 6,609 acre feet (45%) of water, 249 acres (54%) of bottom area

Lower layer, 50 to 65 feet, oxygen deficient, no trout: 740 acre feet (5%) of water, 106 acres (23%) of bottom area

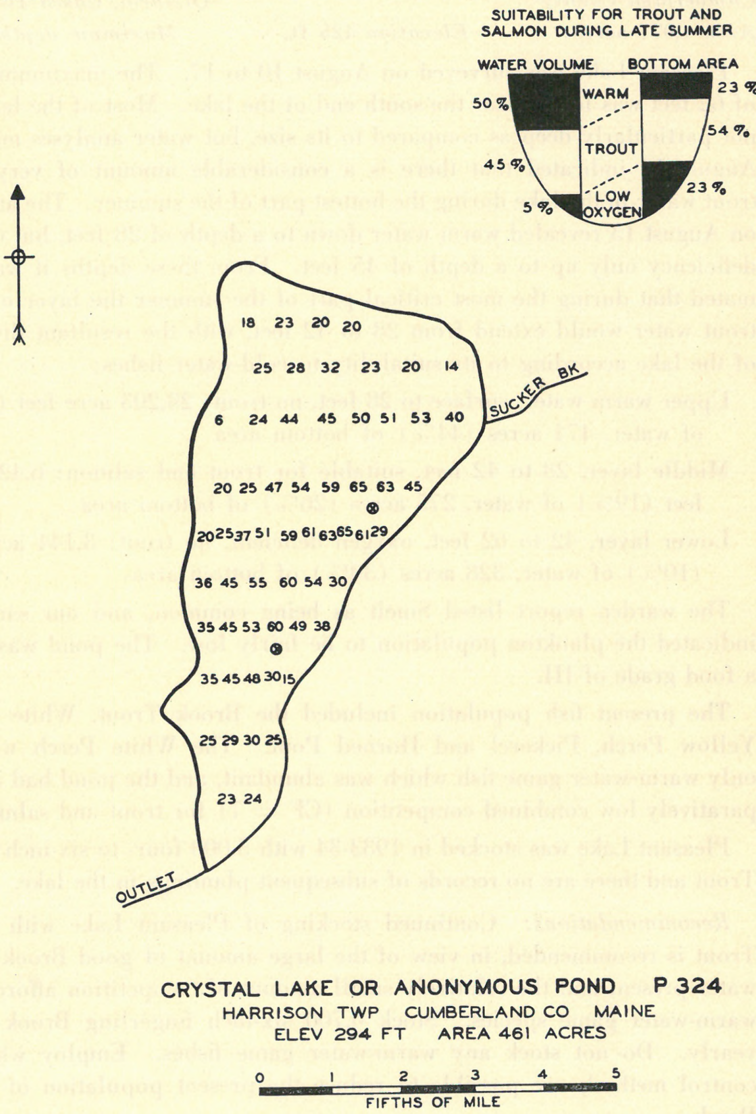
The plankton food supply of Crystal Lake was found to be very low, and the warden reports indicated the Smelt to be common. The pond was given a III food grade for trout.

The fish population present included Land-locked Salmon, Togue (Lake Trout), White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Competition for trout and salmon offered by the warm-water game fishes was quite severe (competition factor 12).

Crystal Lake was stocked during 1934 to 1936 with 10,000 Togue fry and 8,000 four- to six-inch Togue; and during 1937-38 with 5,000 "mature" salmon.

Recommendations: The results of this survey indicate that Crystal Lake has a good water supply for Togue, in spite of the facts that Togue fishing has considerably decreased during the past few years, and the stocking policy has recently been shifted to salmon. The fact that very good water for trouts extends to a depth of 50 feet during the most critical part of the summer is undoubtedly one of the most important reasons why Crystal Lake has been such a good Togue Lake. A yearly stocking of 14,000 two-inch Togue (Lake Trout) fingerlings is recommended. Also stock Smelt, by introducing the eggs, as an attempt to increase the food supply for Togue.

FIG. 19



CRYSTAL LAKE OR ANONYMOUS POND P 324

HARRISON TWP CUMBERLAND CO MAINE

ELEV 294 FT AREA 461 ACRES

PLEASANT LAKE, P. 327

(See map, Fig. 20)

Cumberland County — *Otisfield, Casco* Township

Area 1,077 acres — *Elevation* 425 ft. — *Maximum depth* 62 ft.

Pleasant Lake was surveyed on August 10 to 17. The maximum depth of 62 feet was found near the south end of the lake. Most of the lake was not particularly deep as compared to its size, but water analyses made on August 13 indicated that there is a considerable amount of very good trout water in the lake during the hottest part of the summer. The analyses on August 13 revealed warm water down to a depth of 28 feet, but oxygen deficiency only up to a depth of 45 feet. From these depths it was estimated that during the most critical part of the summer the layer of good trout water would extend from 28 to 42 feet, with the resultant divisions of the lake according to its suitability to cold-water fishes:

Upper warm water, surface to 28 feet, no trout: 23,203 acre feet (71%) of water, 474 acres (44%) of bottom area

Middle layer, 28 to 42 feet, suitable for trout and salmon: 6,421 acre feet (19%) of water, 275 acres (26%) of bottom area

Lower layer, 42 to 62 feet, oxygen deficient, no trout: 3,144 acre feet (10%) of water, 328 acres (30%) of bottom area

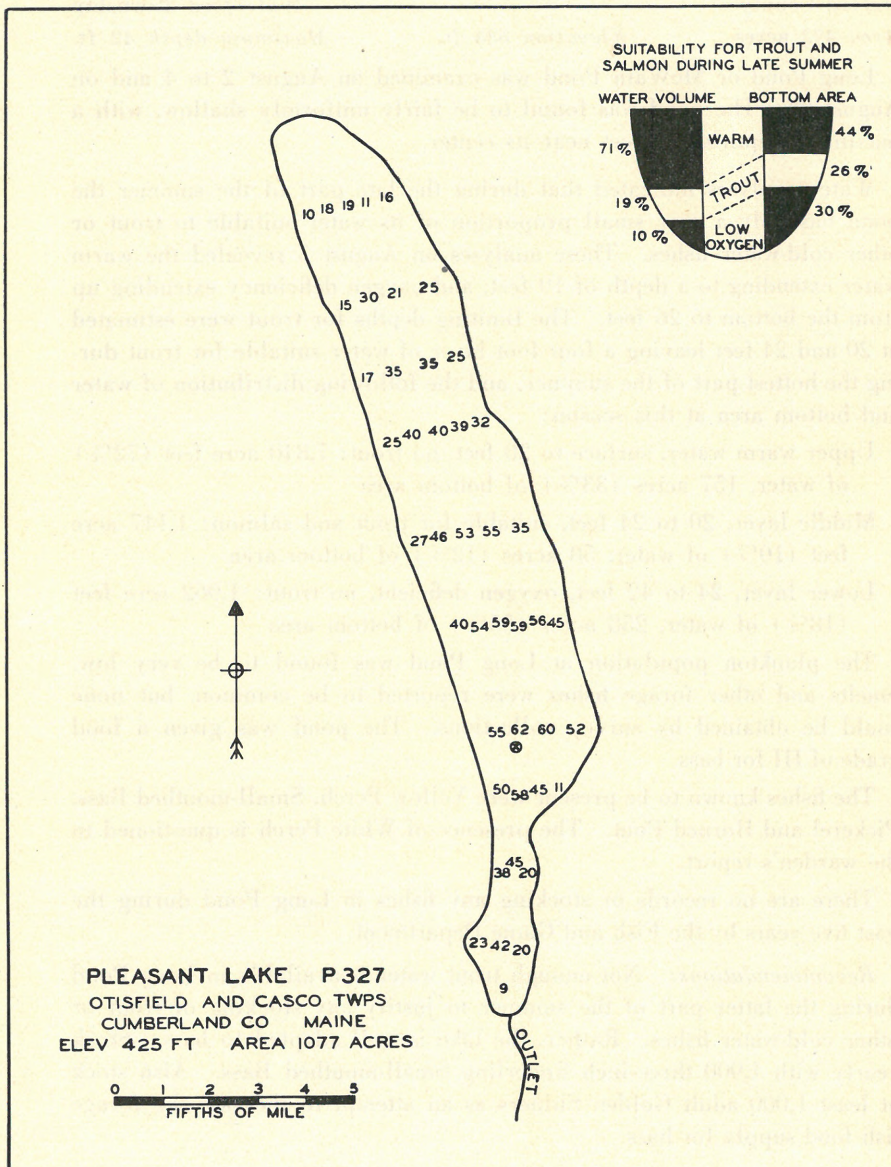
The warden report listed Smelt as being common, and our sampling indicated the plankton population to be fairly low. The pond was given a food grade of III.

The present fish population included the Brook Trout, White Perch, Yellow Perch, Pickerel and Horned Pout. The White Perch was the only warm-water game fish which was abundant, and the pond had a comparatively low combined competition (CF = 7) for trout and salmon.

Pleasant Lake was stocked in 1933-34 with 5,000 four- to six-inch Brook Trout and there are no records of subsequent plantings in the lake.

Recommendations: Continued stocking of Pleasant Lake with Brook Trout is recommended, in view of the large amount of good Brook Trout water present and the relatively small amount of competition afforded by warm-water game species. Stock 6,700 six-inch fingerling Brook Trout yearly. Do not stock any warm-water game fishes. Employ whatever control methods are possible to reduce the present population of White Perch.

FIG. 20


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
71%
19%
10%
44%
26%
30%
10 18 19 11 16
15 30 21 25
17 35 35 25
25 40 40 39 32
27 46 53 55 35
40 54 59 59 56 45
55 62 60 52
50 58 45 11
45 38 20
23 42 20
9
OUTLET
PLEASANT LAKE P 327
OTISFIELD AND CASCO TWPS
CUMBERLAND CO MAINE
ELEV 425 FT AREA 1077 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

LONG POND OR McWAIN POND, P. 332

(See map, Fig. 21)

Oxford County — *Waterford* Township

Area 473 acres — *Elevation* 533 ft. — *Maximum depth* 42 ft.

Long Pond or McWain Pond was examined on August 2 to 4 and on August 23. The pond was found to be fairly uniformly shallow, with a maximum depth of 42 feet near its center.

Water analyses indicated that during the late part of the summer the pond has only a very small proportion of its water suitable to trout or other cold-water fishes. These analyses on August 3 revealed the warm water extending to a depth of 19 feet, and oxygen deficiency extending up from the bottom to 26 feet. The limiting depths for trout were estimated at 20 and 24 feet leaving a four-foot layer of water suitable for trout during the hottest part of the summer, and the following distribution of water and bottom area at this season:

Upper warm water, surface to 20 feet, no trout: 7,840 acre feet (72%) of water, 157 acres (33%) of bottom area

Middle layer, 20 to 24 feet, suitable for trout and salmon: 1,147 acre feet (10%) of water, 58 acres (12%) of bottom area

Lower layer, 24 to 42 feet, oxygen deficient, no trout: 1,962 acre feet (18%) of water, 258 acres (55%) of bottom area

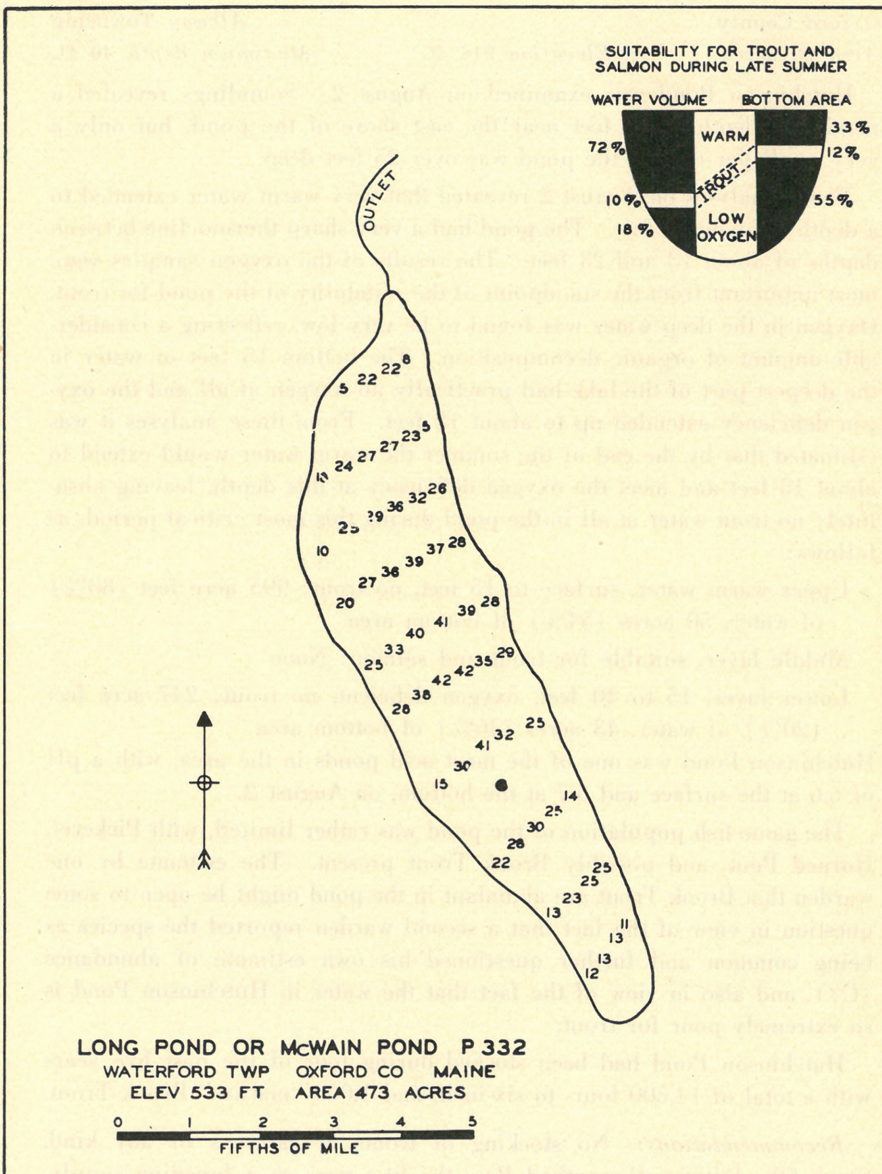
The plankton population at Long Pond was found to be very low. Smelts and other forage fishes were reported to be common, but none could be obtained by survey collections. The pond was given a food grade of III for bass.

The fishes known to be present were Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. The presence of White Perch is questioned in the warden's report.

There are no records of stocking any fishes in Long Pond during the past five years by the Fish and Game Department.

Recommendations: Not enough trout water is available in Long Pond during the latter part of the summer to justify any stocking of trout or other cold-water fishes. Rather, the lake is well adapted to bass. Stock yearly with 1,900 three-inch fingerling Small-mouthed Bass. Also stock at least 1,000 adult Golden Shiners as an attempt to increase the forage fish food supply for bass.

FIG. 21


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
72 %
10 %
18 %
33 %
12 %
55 %
OUTLET
LONG POND OR McWAIN POND P 332
WATERFORD TWP OXFORD CO MAINE
ELEV 533 FT AREA 473 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

HUTCHINSON POND, P. 337

(See map, Fig. 11)

Oxford County | *Albany* Township

Area 93 acres | *Elevation* 916 ft. | *Maximum depth* 40 ft.

Hutchinson Pond was examined on August 2. Soundings revealed a maximum depth of 40 feet near the east shore of the pond, but only a very small per cent of the pond was over 25 feet deep.

Water analyses on August 2 revealed that very warm water extended to a depth of about 13 feet. The pond had a very sharp thermocline between depths of about 13 and 23 feet. The results of the oxygen samples were most important from the standpoint of the suitability of the pond for trout. Oxygen in the deep water was found to be very low, reflecting a considerable amount of organic decomposition. The bottom 15 feet of water in the deepest part of the lake had practically no oxygen at all and the oxygen deficiency extended up to about 18 feet. From these analyses it was estimated that by the end of the summer the warm water would extend to about 15 feet and meet the oxygen deficiency at this depth, leaving absolutely no trout water at all in the pond during this most critical period, as follows:

Upper warm water, surface to 15 feet, no trout: 995 acre feet (80%) of water, 50 acres (54%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 15 to 40 feet, oxygen deficient, no trout: 247 acre feet (20%) of water, 43 acres (46%) of bottom area

Hutchinson Pond was one of the most acid ponds in the area, with a pH of 6.6 at the surface and 5.7 at the bottom, on August 2.

The game fish population of the pond was rather limited, with Pickerel, Horned Pout, and possibly Brook Trout present. The estimate by one warden that Brook Trout are abundant in the pond might be open to some question in view of the fact that a second warden reported the species as being common and further questioned his own estimate of abundance (C?), and also in view of the fact that the water in Hutchinson Pond is so extremely poor for trout.

Hutchinson Pond had been stocked during four of the past five years with a total of 14,500 four- to six-inch, and 1,000 "mature" Brook Trout.

Recommendations: No stocking of trouts or salmons of any kind. Stock 50 adult Small-mouthed Bass the first year as a breeding supply, and stock 750 three-inch Small-mouthed Bass fingerlings yearly.

THOMAS POND, P. 356

(See map, Fig. 22)

Cumberland County | *Casco, Raymond* Township

Area 442 acres | *Elevation* 275 ft. | *Maximum depth* 64 ft.

Thomas Pond was examined on August 16 to 19. Soundings revealed the eastern half of the pond to be quite deep and the western half to be uniformly quite shallow. The maximum depth of 64 feet was found near the east shore of the eastern half of the lake.

Water analyses on August 17 and on August 18, at the same station, revealed water above 75° F. extending to a depth of 15 feet and water above 70° F. extending to a depth of about 19 feet. At the same time oxygen deficiency extended up from the bottom to a depth of about 19 feet. Thus on this date there was absolutely no water in the pond suitable for trout and salmon and there still remained at least two weeks of very warm weather during which conditions of temperature and oxygen would become still more critical. It was estimated that the warm water would be pushed down another foot to at least 20 feet which would actually overlap the area of oxygen deficiency. Any trout living in Thomas Pond in the last half of August would have to remain either in water above 75° F. or in water with less than perhaps 4 p.p.m. of oxygen, or be confined to a layer of water about 1 or 2 feet thick. In fact, Thomas Pond, from the standpoint of temperature and oxygen in the water, was about as poor for trout and salmon as was any of the ponds which were surveyed. The upper warm layer and the deep oxygen-deficient layer were separated as follows:

Upper warm water, surface to 20 feet, no trout: 6,841 acre feet (73%) of water, 205 acres (46%) of bottom area

Middle layer, suitable for trout and salmon: None

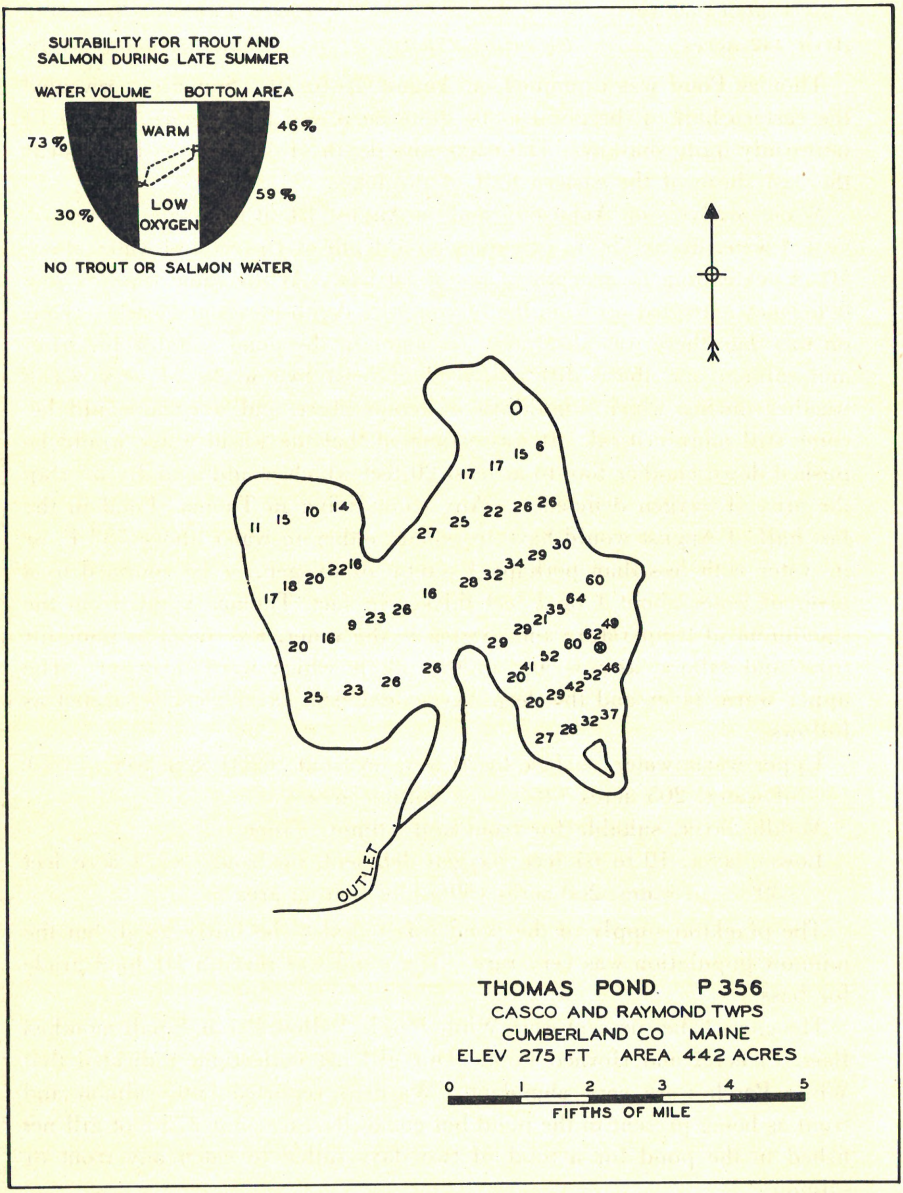
Lower layer, 19 to 64 feet, oxygen deficient, no trout: 2,774 acre feet (30%) of water, 260 acres (59%) of bottom area

The plankton supply of the pond was found to be fairly good, but the minnow population was very rare. The pond was given a III food grade for bass.

The game fishes present were White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Our gill net collections indicated that White Perch were very abundant. Wardens reported both salmon and trout as being present in the pond but generally rare; our 375-foot gill net fished in the pond for a total of two days failed to catch any trout or salmon.

Thomas Pond was stocked during the past five years with a total of 8,300 four- to six-inch, and 5,000 "mature" Brook Trout. Warden reports indicated that a few large trout were taken from Thomas Pond dur-

FIG. 22


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
73 %
46 %
LOW OXYGEN
30 %
59 %
NO TROUT OR SALMON WATER
OUTLET
THOMAS POND P 356
CASCO AND RAYMOND TWPS
CUMBERLAND CO MAINE
ELEV 275 FT AREA 442 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

ing the past few years. That the pond should raise any trout at all, in view of the exceptionally poor temperature and oxygen conditions of the water, is very difficult to explain.

Recommendations: No further stocking of trouts or salmons of any kind. The lake is well adapted to bass and already has a fair bass population, although young bass could be much more abundant. Stock 3,500 three-inch Small-mouthed Bass fingerlings yearly.

PANTHER POND, P. 357

(See map, Fig. 23)

Cumberland County — *Raymond* Township

Area 1,439 acres — *Elevation* 277 ft. — *Maximum depth* 67 ft.

Panther Pond was examined on August 15 and 22. A maximum depth of 67 feet was found at the water analyses station in the northern part of the pond. Most of the pond was quite shallow in proportion to its large size.

Water analyses on August 22 revealed that only a very small proportion of the pond is suitable for trout and salmon, and this amount is too small to justify any stocking of trout and salmon, especially in view of the present large population of warm-water game fishes. On August 22 warm water was found to extend to a depth of 22 feet and oxygen deficiency was found to extend up from the bottom to a depth of 27 feet. It was estimated that by the end of the summer the trout water would be confined to a layer between the 23- and 27-foot depths. The calculated distribution of water and bottom area of the pond with respect to its suitability for trout during the late summer is as follows:

Upper warm water, surface to 23 feet, no trout: 25,895 acre feet (72%) of water, 599 acres (42%) of bottom area

Middle layer, 23 to 27 feet, suitable for trout and salmon: 3,053 acre feet (9%) of water, 151 acres (10%) of bottom area

Lower layer, 27 to 67 feet, oxygen deficient, no trout: 7,012 acre feet (19%) of water, 689 acres (48%) of bottom area

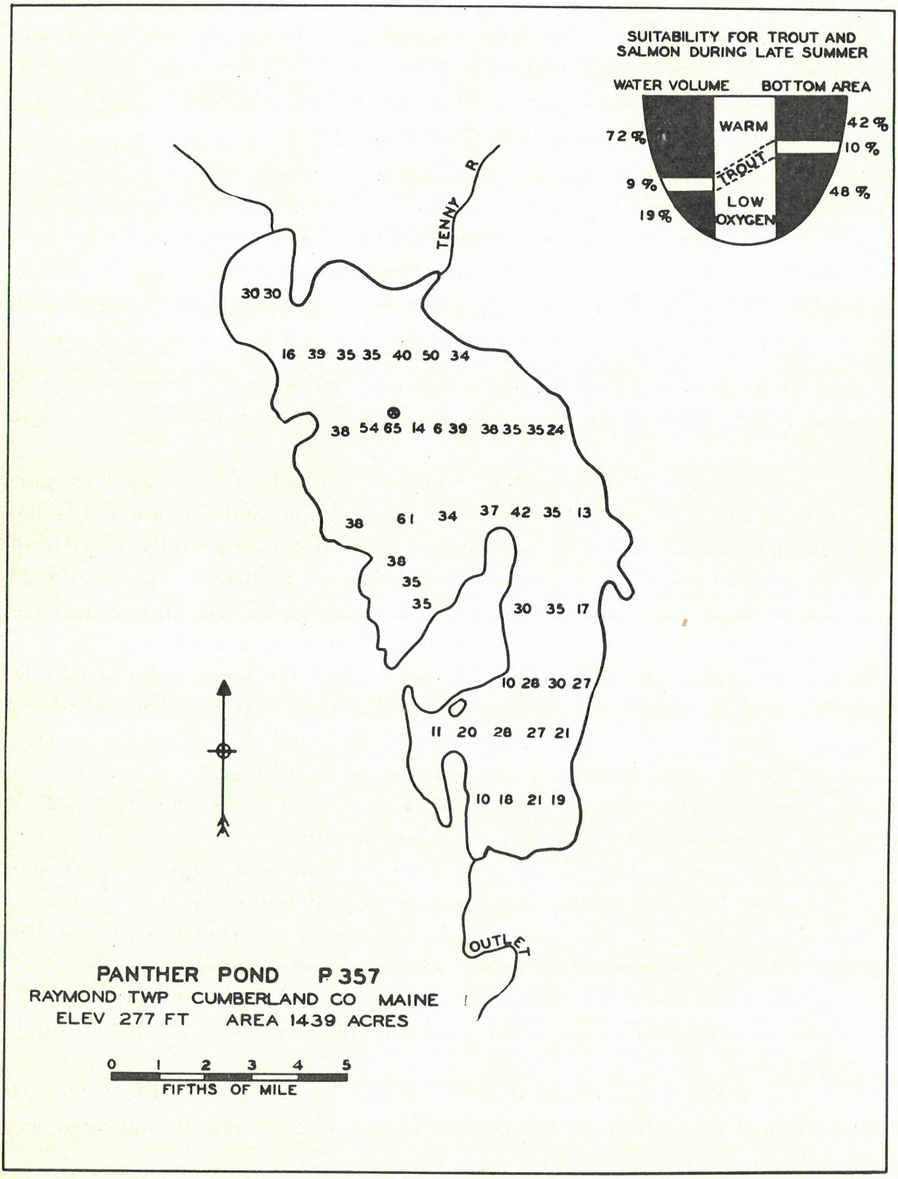
The pond had a fair supply of plankton, but forage fishes available to bass were generally rare. The pond was therefore given a III food grade for bass.

The fishes present included the White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. Warden reports indicated that salmon and trout were rare.

There are no records of Panther Pond being stocked by the Fish and Game Department during the past five years.

Recommendations: No stocking of trouts and salmons of any kind. The lake is well suited to bass. Stock 4,200 three-inch Small-mouthed Bass fingerlings yearly.

FIG. 23


SUITABILITY FOR TROUT AND SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW OXYGEN
72 %
9 %
19 %
42 %
10 %
48 %
TENNY R
OUTLET
30 30
16 39 35 35 40 50 34
38 54 65 14 6 39 38 35 35 24
38 61 34 37 42 35 13
38
35
35
30 35 17
10 28 30 27
11 20 28 27 21
10 18 21 19
PANTHER POND P 357
RAYMOND TWP CUMBERLAND CO MAINE
ELEV 277 FT AREA 1439 ACRES
0 1 2 3 4 5
FIFTHS OF MILE

RATTLESNAKE POND OR CRESCENT LAKE, P. 359

(See map, Fig. 24)

Cumberland County — *Raymond, Casco* Township

Area 822 acres — *Elevation* 277 ft. — *Maximum depth* 50 ft.

Rattlesnake Pond or Crescent Lake was examined during the period of August 18 to 23. The maximum depth of 50 feet was found at the water analyses station in the north end of the lake. The water analyses on August 22 revealed 76° F. water extending to a depth of 20 feet and water above 70° F. extending to a depth of 25 feet. Oxygen depletion in the deep water had been extreme. Tests at 35 and 48 feet revealed no oxygen at all, and there was too little oxygen for trout or salmon up to a depth of about 20 feet. Thus, on this date, there was absolutely no water in the pond suitable for trout and salmon. If such fish were present they had to be either in water above 76° F. in temperature or in water with less than 4 p.p.m. of oxygen. From these analyses it was estimated that during the next week or two of the last part of the summer, conditions would become still more extreme, with oxygen deficiency extending up to about 18 feet and overlapping the warm water zone by at least 7 feet. The amounts of water and bottom area in the upper warm water zone and lower oxygen-deficient zone were as follows:

Upper warm water, surface to 25 feet, no trout: 15,895 acre feet (83%) of water, 370 acres (45%) of bottom area

Middle layer, suitable for trout and salmon: None

Lower layer, 18 to 50 feet, oxygen deficient, no trout; 6,813 acre feet (36%) of water, 560 acres (68%) of bottom area

According to our water analyses the water in Rattlesnake Pond was the poorest for trout and salmon, from the standpoint of temperature and oxygen, of all the ponds which were studied.

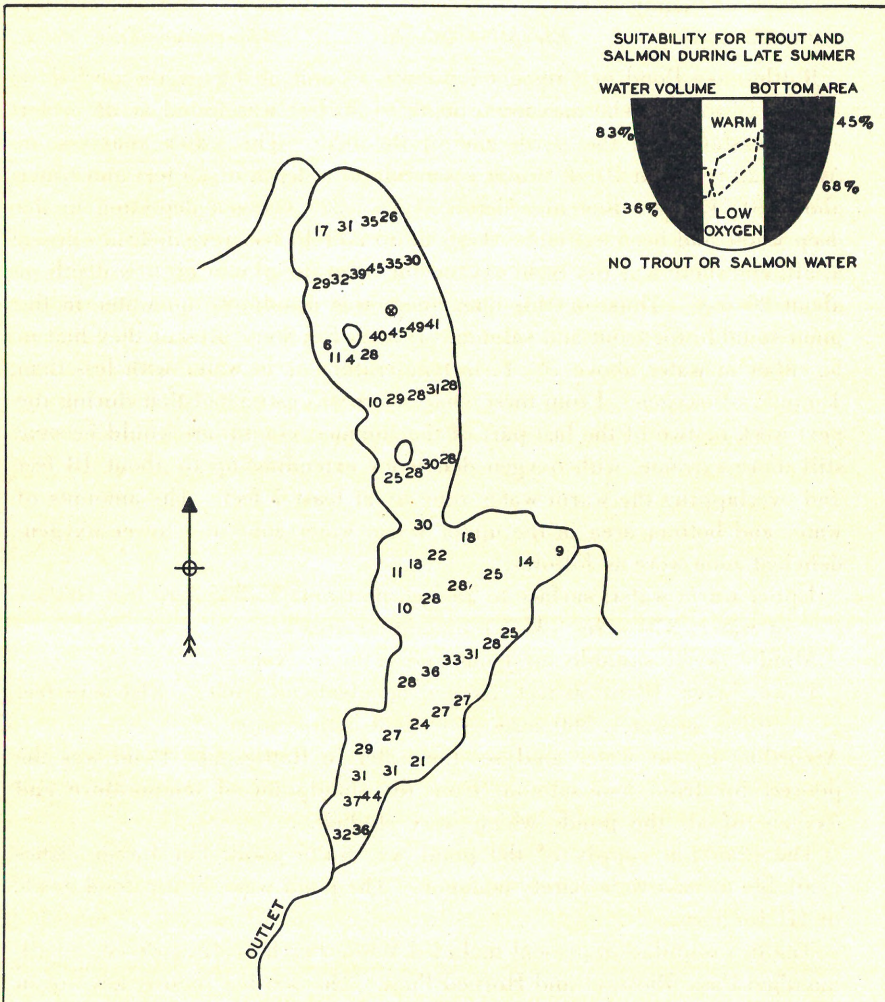
The plankton supply of the pond was quite good, but forage fishes available to bass were barely common. The pond was given a food grade of III for bass.

The fish population present included White Perch, Yellow Perch, Small-mouthed Bass, Pickerel and Horned Pout. The warden reports gave trout as probably present but rare and salmon as rare or absent. White Perch were by far the most abundant of the warm-water game fishes. The pond is well adapted to bass but the present bass population is quite scarce, especially the young.

Rattlesnake Pond was stocked in 1934 with 7,000 four- to six-inch Land-locked Salmon and in 1936 with 10,000 four- to six-inch Chinook Salmon. Our 475-foot gill net set for 22 hours took no salmon.

Recommendations: No stocking of trout or salmon of any kind. Stock 6,500 three-inch Small-mouthed Bass fingerlings yearly.

FIG. 24



RATTLESNAKE POND OR CRESCENT LAKE P 359
RAYMOND AND CASCO TWPS
CUMBERLAND CO MAINE
ELEV 277 FT AREA 822 ACRES

0 1 2 3 4 5
FIFTHS OF MILE

COFFEE POND, P. 362

(See map, Fig. 25)

Cumberland County — *Casco* Township

Area 137 acres — *Elevation* 460+ ft. — *Maximum depth* 70 ft.

Coffee Pond was examined on August 13 and 15. It was found to be mostly very deep as compared to its size. The maximum depth of 70 feet was found in the center of the main part of the pond. Water analyses on August 15 indicated that this is an excellent trout and salmon pond from the standpoint of temperature and oxygen. The warm water was found to extend to the considerable depth of about 24 feet but oxygen deficiency in the deep water had extended up only to a depth of 53 feet. From these depths it was estimated that during the most critical part of the summer there would be good trout water between the depths of 24 and 50 feet, and the following division of the pond with respect to its suitability for trout:

Upper warm water, surface to 24 feet, no trout: 2,880 acre feet (60%) of water, 33 acres (24%) of bottom area

Middle layer, 24 to 50 feet, suitable for trout and salmon: 1,647 acre feet (34%) of water, 71 acres (52%) of bottom area

Lower layer, 50 to 70 feet, oxygen deficient, no trout: 293 acre feet (6%) of water, 33 acres (24%) of bottom area

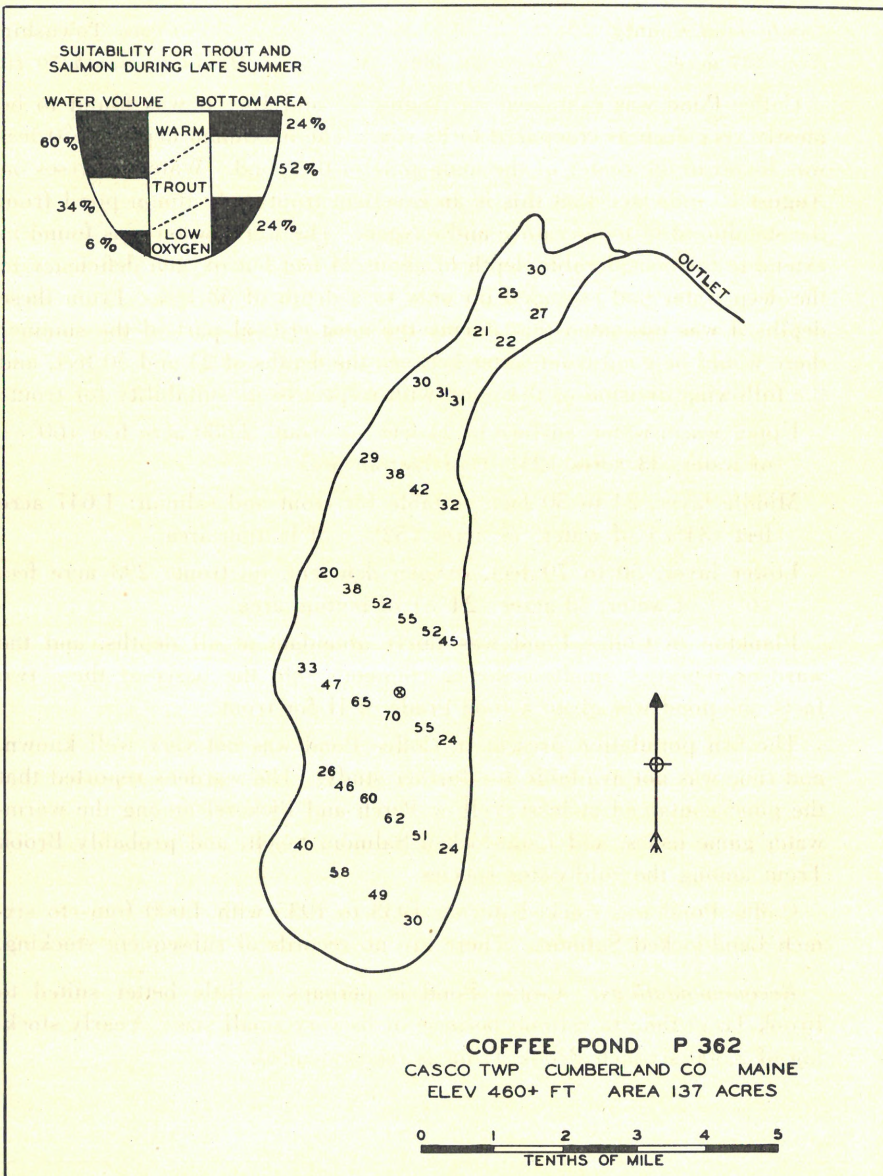
Plankton in Coffee Pond was fairly abundant at all depths, and the wardens reported Smelt as being common. On the basis of these two facts, the pond was given a food grade of II for trout.

The fish population present in Coffee Pond was not very well known, and time was not available for further study. The wardens reported that the pond contained at least Yellow Perch and Pickerel among the warm-water game fishes, and Land-locked Salmon, Smelt, and probably Brook Trout among the cold-water species.

Coffee Pond was stocked during 1933 to 1935 with 4,000 four- to six-inch Land-locked Salmon. There are no records of subsequent stocking.

Recommendations: Coffee Pond is perhaps a little better suited to Brook Trout than to salmon because of its very small size. Yearly stocking of 2,500 six-inch Brook Trout is recommended.

FIG. 25


SUITABILITY FOR TROUT AND
SALMON DURING LATE SUMMER
WATER VOLUME
BOTTOM AREA
WARM
TROUT
LOW
OXYGEN
60 %
34 %
6 %
24 %
52 %
24 %
OUTLET
COFFEE POND P 362
CASCO TWP CUMBERLAND CO MAINE
ELEV 460+ FT AREA 137 ACRES
0 1 2 3 4 5
TENTHS OF MILE

OBSERVATIONS ON QUIMBY POND IN RANGELEY, LILY POND IN DEER ISLE AND GEORGES POND IN STONINGTON

Observations on Quimby, Lily and Georges ponds were made in the summer of 1938, in addition to the studies in the main survey area. Since these ponds are located at a considerable distance from the general region of the large group of ponds which were studied, they are considered in this separate Appendix.

QUIMBY POND

(See map, Fig. 26)

Franklin County | *Rangeley* Township

Area 165 acres | *Maximum depth* 12 ft.

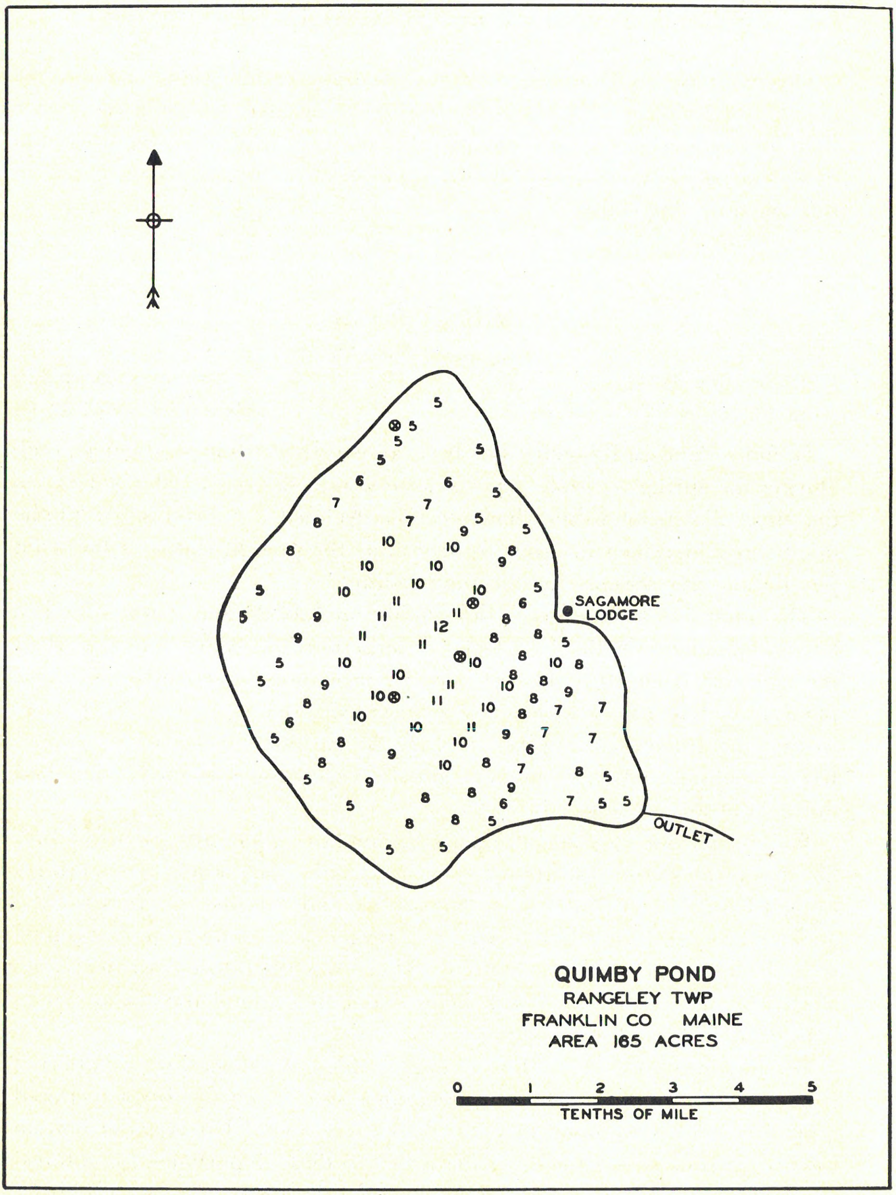
Quimby Pond in Rangeley has been an excellent trout producing pond. During the spring of 1938, reports were obtained from local residents to the effect that trout fishing had recently declined. A brief study of the pond was undertaken in order to determine the present status of the trout population and reasons for the poor fishing.

The pond was sounded very thoroughly on July 23 and it was found to have a maximum depth of 12 feet. A large portion of the central part of the lake was from 10 to 11 feet deep. Throughout practically the entire pond, there was a thick layer of very flocculent organic mud on the bottom so that the soundings as given in Fig. 26 represent water plus about 2 feet of bottom mud. Submergent aquatic vegetation was fairly abundant throughout the entire pond.

Water analyses were made during the middle of the afternoon on July 23 at several stations scattered over the pond. The water temperatures ranged from 71.6 to 72.0° F. at the surface and varied from 70.3 to 72.0 at the bottom in 8 to 9 feet of water. Oxygen was found to be 9.0 p.p.m. at both the surface and the bottom. There was, therefore, practically no stratification, for the water was being circulated completely from top to bottom by wind and wave action.

Thirteen samples (9″ x 9″) of bottom food organisms were collected from the pond on July 24. These samples were from localities scattered quite evenly over the pond in water 6 to 9 feet deep. The types of bottom food organisms encountered, in the order of their importance by volume, were: Midge larvae, Fresh-water shrimp, Dragonfly larvae, Caddisfly larvae, leeches, mollusks and aquatic earthworms. The number of organisms per sample varied from 34 to 861; the volume per sample varied from 0.9 c.c. to 1.46 c.c. The total number and volume of each type of

FIG. 26


SAGAMORE LODGE
OUTLET
QUIMBY POND
RANGELEY TWP
FRANKLIN CO MAINE
AREA 165 ACRES
0 1 2 3 4 5
TENTHS OF MILE

organism in the thirteen samples and the calculated number and volume per square foot of lake bottom (as based on the 13 samples) are given in Table XIV. Quimby Pond was found to be many times as rich in bottom

TABLE XIV. The total number and volume of each type of organism in 13 bottom samples and the calculated number and volume per square foot of lake bottom for Quimby Pond

Bottom organisms	Total contents of thirteen 9″ by 9″ bottom samples		Calculated bottom fauna per square foot	
	Number	Volume in c.c.	Number	Volume in c.c.
Mollusca (snails and clams)	10	0.09	1.4	0.01
Midges (Chironomids)	1,605	2.96	219.5	0.40
Caddisflies (Trichoptera)..........	4	0.38	0.5	0.05
Dragonflies (Anisoptera)	3	1.13	0.4	0.15
Fresh-water shrimp (Amphipoda) ..	560	2.69	76.6	0.37
Leeches (Hirudinia)	3	0.21	0.4	0.03
Aquatic earthworms (Chaetopoda) .	2	0.03	0.3	0.01
All organisms	2,187	7.49	299.1	1.02

food organisms as were any of the four ponds in southern Maine which were similarly studied in 1938. Quimby Pond can be classed as rich in bottom fauna as compared to other lakes in general.

Plankton samples collected from Quimby Pond on July 24 revealed a plankton population very much in excess of that in any of the lakes in the southern part of Maine which were studied. The average volume of plankton per cubic foot of lake water, between the depths of 5 feet and the surface, was calculated to be 3.43 c.c.; the average number of individual planktonts within this same depth range was calculated at approximately 7,400,000 per cubic foot. Of these plankton forms, the green algae numbered about 4,800,000, the blue-green algae about 1,500,000 and the diatoms 700,000. Desmids and protozoans were present in smaller numbers. Copepods averaged 571 per cubic foot and Cladocerans 286. On the basis of the abundance of both plankton and bottom food organisms, Quimby Pond was rated very high in fertility and given a food grade of I.

Gill nets fished in Quimby Pond caught nothing except Brook Trout, and the size of the catch indicated that Brook Trout were still very abundant in the pond. No attempt could be made to estimate the actual population. According to wardens and local residents, Quimby Pond has suckers and some species of minnows in addition to Brook Trout, but no other species of game fish. None of the suckers or minnows were encountered during this study.

Stomach samples from 22 Brook Trout taken from Quimby Pond on July 23 and 24 were examined for food contents. This analysis can be summarized briefly as follows: all of the trout except two contained some food and this stomach content material was made up entirely of bottom food organisms. Dragonflies made up about 85 per cent of all the food material; the remaining 15 per cent included fresh-water shrimp and leeches. The results of this examination are of particular interest in connection with the reports by local residents that sportsmen had not been able to catch very many trout during the spring of 1938. Fishing on Quimby Pond is restricted to fly-fishing and, as defined by law, fly fishing must be confined to the surface water. There was a large population of Brook Trout present and, at the time of our study, they were feeding almost exclusively on food organisms which were on the bottom of the pond. It seems probable that the reason fishermen were not catching many fish was that the trout were not particularly interested in artificial flies offered to them at the surface.

The study of Quimby Pond has been of considerable interest and value to the lake survey program for southern Maine in that Quimby Pond possibly represents conditions which might exist in a great many ponds if warm-water game fishes were completely absent. It has been mentioned in connection with the survey of the lakes and ponds in the southern part of the state that the upper temperature limit has been set at 70° F. for those lakes of southern Maine in which warm-water game fishes are present. The conditions in Quimby Pond, and the fact that wardens from the northern part of Maine have stated that similar ponds occur in their districts, constitute fairly conclusive evidence that Brook Trout, in general, might do very well in water above 70° F., if they did not have to compete with warm-water game fishes.

Recommendations: It is not within the purpose of the present survey to recommend methods of fishing. It is believed, however, that trout could have been caught abundantly from Quimby Pond during 1938 if the proper type of bait had been used and if this bait had been fished at the bottom of the pond.

Some estimate of the productivity and carrying capacity of the pond for trout is available from the present study. On the basis of a I food grade for trout, poor spawning facilities, and light fishing intensity, the pond should be stocked at the rate of 3,600 six-inch fingerling Brook Trout yearly.

LILY POND

(See map, Fig. 27)

Hancock County | *Deer Isle* Township

Area 37 acres | *Elevation* 80+ ft. | *Maximum depth* 21 ft.

Lily Pond in Deer Isle was sounded on August 12. A maximum depth of 21 feet was found near the center of the pond. Approximately half of the pond was over 17 feet deep. There was only a comparatively small amount of organic mud on the bottom in deep water, and none in shallow water.

Water analyses were made on August 12 (see Table XV). The water was white and very clear. Water above 70° F. extended to a depth of about 17 feet. The oxygen content at the bottom (5.1 p.p.m.) was just above the minimum requirement for trout. The pH was 7.0 at the surface and 6.4 at the bottom, or less acid than most small ponds in southern Maine. From these analyses it was estimated that, by the end of August, 70° F. water would extend to the bottom, and oxygen would be sufficient

TABLE XV. Water analyses on Lily Pond, Deer Isle Township, Hancock County. Date: August 12, 1938; Time: 2:15 to 2:45 P.M.; Depth of water: 19 feet; Station: near the center of the pond

Depth in feet	Temperature: °F.	Oxygen: p.p.m.	pH: Bromthymol Blue
Surface	74.5	9.0	7.0
10	73.9	8.8	7.0
15	72.5	5.3	6.5
18	69.3	5.1	6.4

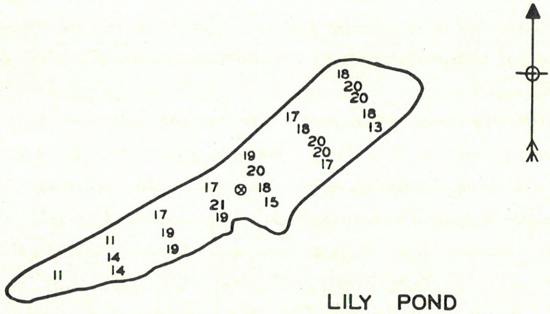
for trout at all depths. The water in the deeper half of the pond undoubtedly would not exceed the low seventies in temperature, because the pond is small and well protected from the wind.

Local residents reported the following concerning the fish population of Lily Pond. Past stockings with trout and salmon have produced some salmon fishing. The only other large fishes present are eels and suckers. There are no bass, perch, pickerel or other warm-water game fishes.

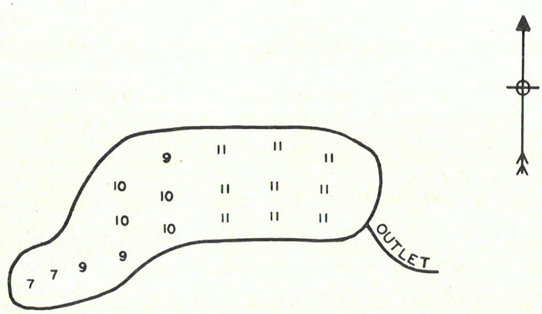
Lily Pond is classed as a fair trout pond on the basis of the water supply and in view of the general absence of competing warm-water game species. If perch, bass, or pickerel were present, the pond would be classed as poor trout water.

Recommendations: Stock yearly 550 six-inch fingerling Brook Trout. If this stocking gives poor returns after about three years, change stocking to 550 six-inch Brown Trout.

FIG. 27



LILY POND
DEER ISLE TWP
HANCOCK CO MAINE
ELEV 80+ FT AREA 37 ACRES



GEORGES POND
STONINGTON TWP
HANCOCK CO MAINE
ELEV LESS THAN 20 FT
AREA 10 ACRES ESTIMATED

GEORGES POND

(See map, Fig. 27)

Hancock County *Stonington* Township
Area 10 acres (estimated) *Elevation* less than 20 ft. *Maximum depth* 11 ft.

This pond was examined on October 22. Soundings revealed the bottom to be quite flat at 9 to 11 feet. The maximum depth was 11 feet. The bottom was mostly a thick layer of flocculent organic mud. Aquatic vegetation was very abundant. The water was very dark brown. Georges Pond is one of that type of pond which is approaching its final stage of being filled up rapidly with vegetable debris. It resembles the shallow, dark-water, dystrophic type of pond which, in Maine, rarely if ever produces any trout fishing.

Seining revealed the Golden Shiner and Banded Top-minnow to be abundant, the Pumpkinseed Sunfish common, and the Nine-spined Stickleback rare. No game fishes were found or reported to be present.

Recommendations: Stock no trout or salmon of any kind. Also, the pond is so poorly adapted to Small-mouthed Bass that stocking with this species probably would be wasted. An experimental stocking with Common Pickerel *(Esox niger)* is recommended.

Appendix B

FIELD AND LABORATORY METHODS OF LAKE SURVEY

The following are the methods which were used in the present survey and which will probably be used with some modification in future surveys of this type. For a more complete description of modern methods of lake and stream survey, see Davis, H. S.: 1938, "Instructions for Conducting Stream and Lake Surveys," U. S. Bureau of Fisheries, Fishery Circular No. 26.

Morphometry

All lakes and ponds were sounded, using a water-resistant braided tiller rope with bronze center, attached to a five-pound piece of iron. The rope was marked at intervals of five feet and distances between these five-foot markings were estimated when sounding. A rough outline map of the lake was redrawn from the U. S. Geological Survey Topographic Maps. All prominent points, bays, islands, locations of buildings and other land marks were prominently indicated on this sketch map so that the approximate position of the party doing the sounding could be determined at all times by reference to this map. Soundings were made from a motor boat which was run in a straight line from one side of the lake to the other between prominent and known landmarks. The positions of individual soundings on each of these lines were usually estimated, but, for some lakes, was calculated by recording the actual amount of time traveled between successive soundings with the motor of the boat running at a constant speed. All depth soundings were located on each field sketch map.

The map of each lake or pond as given in this report was prepared in the laboratory by enlarging or reducing the lake outline from the United States Geological Survey Topographic Maps, using cross-hatched paper with various sizes of squares as the basis for enlarging or reducing. Soundings were transferred from the field sketch map to the final map by this same cross-hatch method. Depth contours were drawn on the prepared maps on the basis of the soundings. The total area of each lake was obtained by using a planimeter on the lake outline on the Topographic maps; the total area of each pond was also checked on maps prepared for this report. The area within each depth contour on the prepared maps was obtained also by a planimeter. For determining the amount of trout or salmon water, contours were drawn for those depths which were estimated as the critical temperature and oxygen depths for trout during late summer. On most lakes, from two to four other depth contours were drawn, in order to divide the lake up into fairly equal areas between contours; this was done to minimize the error in computing area and water volume.

In computing the volume of the water of a lake between various depth levels, each lake was considered to be a series of frustums, and the following formula was used to calculate the volume of the water in each frustum (as for example between the surface and a depth of ten feet):

Volume of water in acre-feet between two given levels =

$$1/3\ h\ (A_1+A_2+\sqrt{A_1A_2})$$

Where h = depth of water in feet (10 feet as of the example)

A_1 = the total area in acres of the lake (for the upper-most frustum), or the area within the contour for the depth marking the upper limit of the frustum

A_2 = area in acres within the contour for the depth representing the lower limit of the frustum (area within the 10-foot contour, in example)

The volume of water in each frustum of a lake was calculated and the total volume of the lake was obtained by adding the volumes of the separate parts.

The values for surface area between depth contours of a lake were obtained by using a planimeter on our own prepared maps. These values were assumed to be also the values for the bottom area of the lake between these depth contours. Making this assumption introduces only an extremely small error because of the fact that the ratio of depth to surface linear dimensions of any of these lakes was extremely small.

Accuracy of Methods of Morphometry

The degree of accuracy necessary in any calculation is in proportion to the desired degree of precision in interpreting the results. The above methods in morphometry as used on the lakes and ponds which were surveyed are not particularly refined from the standpoint of the professional surveyor. Some of the possibilities of error in the above methods are:

1. Constructing the lake outline map by the crosshatch method from the U. S. Geological Survey Topographic Sheets introduces a considerable amount of error in the area and in details of the shoreline of the lake, because of the fact that the outline of most lakes is so small on the topographic maps.
2. Obtaining the figures for the lake area by using the planimeter on a U. S. Topographic map is subject to a considerable amount of error, especially on the smaller lakes because of the small size of the lake outline.
3. The method of locating the soundings was subject to some error. However, the importance of this error is believed to be considerably minimized because of the fact that the bottom areas of most of these lakes was found to be comparatively flat.

4. Some error was involved in locating depth contours on the lake outline.
5. Some error was involved by assuming the lake to be a series of frustums with uniform degree of slope between successive depth contours. This source of error was minimized by using several contours spaced fairly uniformly according to depth and area.
6. The assumption that the surface area of the lake was the same as the bottom area introduced only a very small error, since the ratio of vertical depth to horizontal distance was so small in the lakes which were studied.

It is believed that these several possible sources of error have introduced only a relatively small amount of error in the final results, and that the results in calculating the amount of water and bottom area in each pond suitable for trout and salmon are fairly accurate.

Temperature (See Plate I)

In all instances temperatures were taken by lowering the thermometer to the desired depth. Two types of thermometers were used: (1) the latest type of Negretti and Zambra deep sea reversing thermometer, and (2) a Taylor maximum-minimum registering thermometer. The maximum-minimum thermometer was checked against the Negretti and Zambra instrument and the former was found to be accurate to within plus or minus ½ degree Fahrenheit. All temperatures which are given in this report to the nearest tenth of a degree were taken with the Negretti and Zambra thermometer, and all temperatures given to the nearest whole degree were taken with the maximum-minimum thermometer. Both thermometers were operated on a water resistant, braided tiller rope, with bronze center, marked at five-foot intervals. The thermometers were left at the desired depth for approximately two minutes. Temperature readings were taken at the same time and at all stations where tests on oxygen and pH were made (see station ⊗ on maps). Temperature readings were taken at more frequent depth intervals in the region of the thermocline where the temperature was changing rapidly, and at less frequent intervals in the epilimnion and hypolimnion where change of temperature with depth was rather slow.

The temperature readings as obtained during the analyses were used as a basis in estimating the depth to which the critical maximum temperature for trout and salmon (70° F.) would extend during the most critical late summer period; in making these estimates the size of the lake, sharpness of the thermocline at the time of analyses, and depth to which 70° F. water extended on the day of the analyses, were all considered.

Oxygen and pH (see Plates II and III)

Samples of lake water were obtained from each desired depth by using a Foerst Improved Water Sampler of 2,000 c.c. capacity. The sampler was attached to a water-resistant braided tiller rope, with bronze center, which was marked at five-foot intervals. As the sampler was being let down to the desired depth, care was taken to lower it very slowly during the last 10 feet of its descent (not faster than 1 foot in 5 seconds) in order to avoid mixing the water near the point from which the sample was taken.

For tests on oxygen, water from the sampler was released through a one-foot rubber hose attached to the outlet of the sampler. The end of this hose was inserted to the bottom of the sampler bottle. Samples were collected in glass-stoppered bottles of 250 c.c. capacity. Approximately 1,000 c.c. of the water from the sampler was passed through the sample bottle in order to drive out any water which might have been contaminated by contact with the air at the surface. This water sample was analyzed for oxygen by the Winkler method (manganous sulphate, alkaline potassium iodide, sulphuric acid, sodium thiosulphate). The sodium thiosulphate was standardized about once a week against a solution of potassium biniodate (of known strength). The results of the oxygen analyses as given in this report are expressed in parts-per-million by weight of dissolved oxygen in water.

Ten c.c. of water from each sample were collected in a test tube and this was analyzed for pH (acid intensity) colorimetrically, using LaMotte color standard solutions and indicator solutions—Bromthymol Blue and Bromcresol Purple covered the entire range of acidity which was encountered in the lakes which were studied. Unless otherwise noted in Table II which gives the results of water analyses, all pH tests of 5.5 to 6.3 were made with Bromcresol Purple, and all tests from 6.4 to 7.1 were made with Bromthymol Blue indicator.

Plankton (see Plates IV and V)

Plankton samples were collected by using a Birge Closing Net. The opening at the top of this net was 10 cm. in diameter. The net was fitted to a water-resistant braided tiller rope with bronze center marked at five-foot intervals. The plankton net was hauled at as uniform a rate as possible, and approximately at the rate of ½ meter per second. The coefficient of the efficiency of the net was figured as 1.2; that is, the theoretical volume of water in the sample column was multiplied by 1/1.2 to give the volume of water which actually passed through the net.[12] Samples

[12]The coefficiency factor of 1.2 for this type of plankton net hauled at the rate of ½ meter per second was calculated by George Kemmerer, J. F. Bovard, and W. R. Boorman, 1923: Northwestern lakes of the U. S.: biological and chemical studies with reference to the possibilities of production of fish. U. S. Bur. Fish., Doc. No. 944 (see p. 65).

were taken separately from different depth strata of the deeper lakes. Usually 2, and sometimes 3 hauls of the net were made between two given depth levels of each lake. Plankton samples were preserved in five per cent formalin.

Analyses of the plankton samples[13] were made in the laboratory. Each sample was diluted or condensed to 100 c.c. and was then settled for at least 24 hours in a 100 c.c. glass graduated tube with tapered bottom. The figures on the volume of plankton as given in this report represent the volume of the mass of plankton after settling in this tube. The readings on volume could be made quite accurately to the nearest 0.1 c.c. A slight error was involved in determining volume, due to the failure of some planktonts to settle.

Quantitative plankton counts were made by major taxonomic groups of the various forms present. One random sample of 1 c.c. from each of the plankton samples collected in the field was put in a standard counting cell (20 x 50 x 1 mm.). The counting field of the microscope covered 1.04 square millimeters, or 1.04 cubic millimeters. Ten counts on all plankton forms were made on each sample in the plankton counting cell. In addition, the total numbers of the larger planktonts (Cladocera and Copepoda) in the entire 1 c.c. sample were counted. These plankton counts were used to calculate the total number of planktonts present in the entire sample collected from each lake, and also the average number of each type of plankton per cubic foot of lake water throughout the depth range of the sample.

Bottom Fauna (see Plate VI)

Bottom fish food organisms were collected with an Ekman dredge designed to scoop up a bottom sample nine inches square. Each entire bottom sample was strained through brass sieves with No. 20 and No. 40 mesh size (number of meshes per inch). All organisms in each sample were preserved in alcohol. The numbers and volumes (by water displacement) of each type of bottom organism in each sample were determined in the laboratory. These data were used to calculate the number and volume of food organisms per square foot of lake bottom.

Fish Populations

Collections were made to determine the kinds and abundance of fishes, using seines and gill nets. The seines, found to be most effective in the work, were of two types: (1) common sense minnow seines 6 to 30 feet in length, and (2) gold medal minnow seines with ¼- and ⅜-inch mesh and up to 30 feet long. Seining was done almost entirely in shallow

[13]Plankton samples were analyzed by Mr. J. H. Saveraid, graduate fellow in the Division of Wildlife Research at the University of Maine.

water. The survey party seined for at least several hours in each lake and usually along at least 200 to 300 yards of shore shallows.

Two different gill nets were used, namely: (1) an experimental type, 475 feet by 6 feet, made up of 7 units as follows: 5 units each 75 feet long with mesh sizes of 4, 2, 6, 3, 5 inches, stretched measure (twice bar measure), one unit 70 feet long with 2⅜-inch mesh, and one unit 30 feet long with 2¾-inch mesh; and (2) a 150-foot by 12-foot gill net with 5-inch mesh. The experimental net of various sizes of mesh was very effective in catching fish; however, the 150-foot net caught practically no fish during the entire summer, probably because both the thread and mesh were too large. In those lakes where nets were set for more than one night, each net was set at a different depth the second night from that of the first. In those lakes where the net was set only one night, it was set so that it extended from fairly shallow into fairly deep water, whenever this was possible. The usual depth range of the gill net sets in most of the ponds was 15 to 35 feet. It is believed that in most instances the gill nets obtained a fairly representative sample of the adult food and game fishes which were known to be present.

PLATE I

Taking water temperatures with a Negretti and Zambra Deep Sea Reversing Thermometer.
Left: Thermometer as it is lowered. Left Center: Thermometer in reversed position as it is pulled to the surface.
Right: Close-ups of thermometer and case.

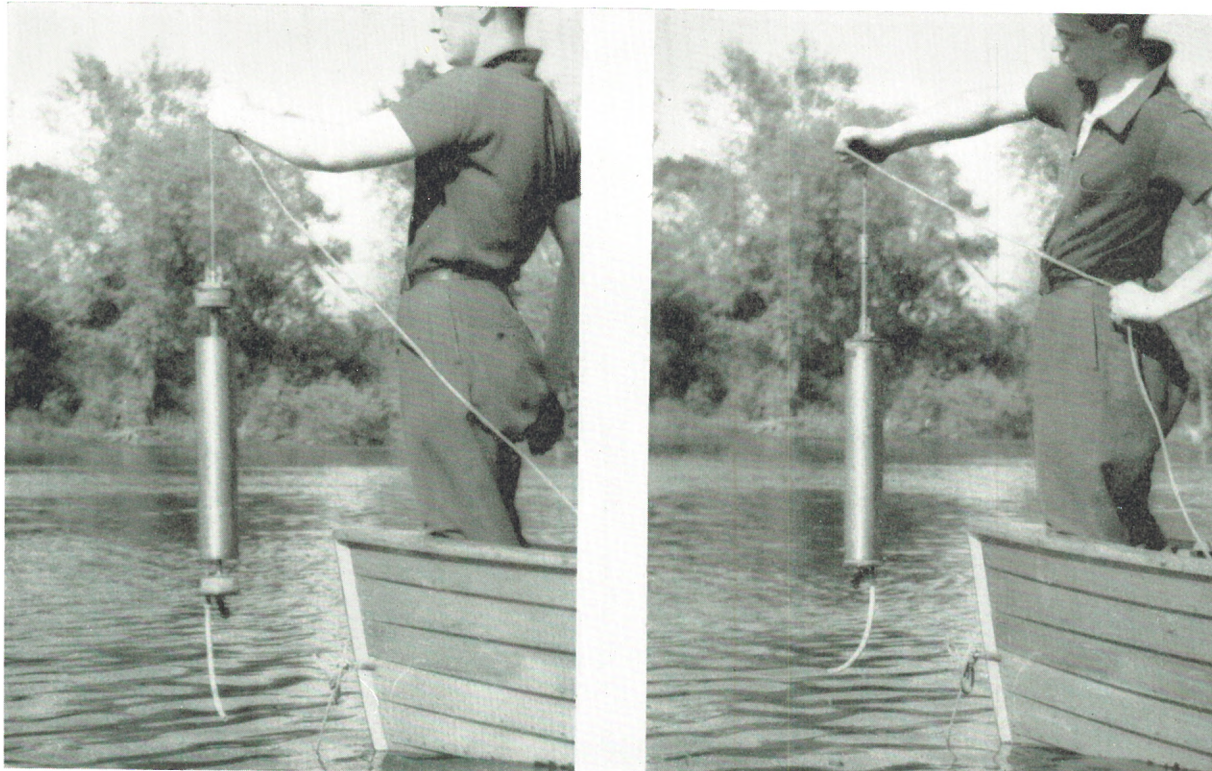


PLATE II

Collecting samples of water from various depth levels with a Foerst Improved Water Sampler of 2,000 c.c. capacity.

Left: Sampler open as it is let down. Right: Sampler closed and pulled to the surface.

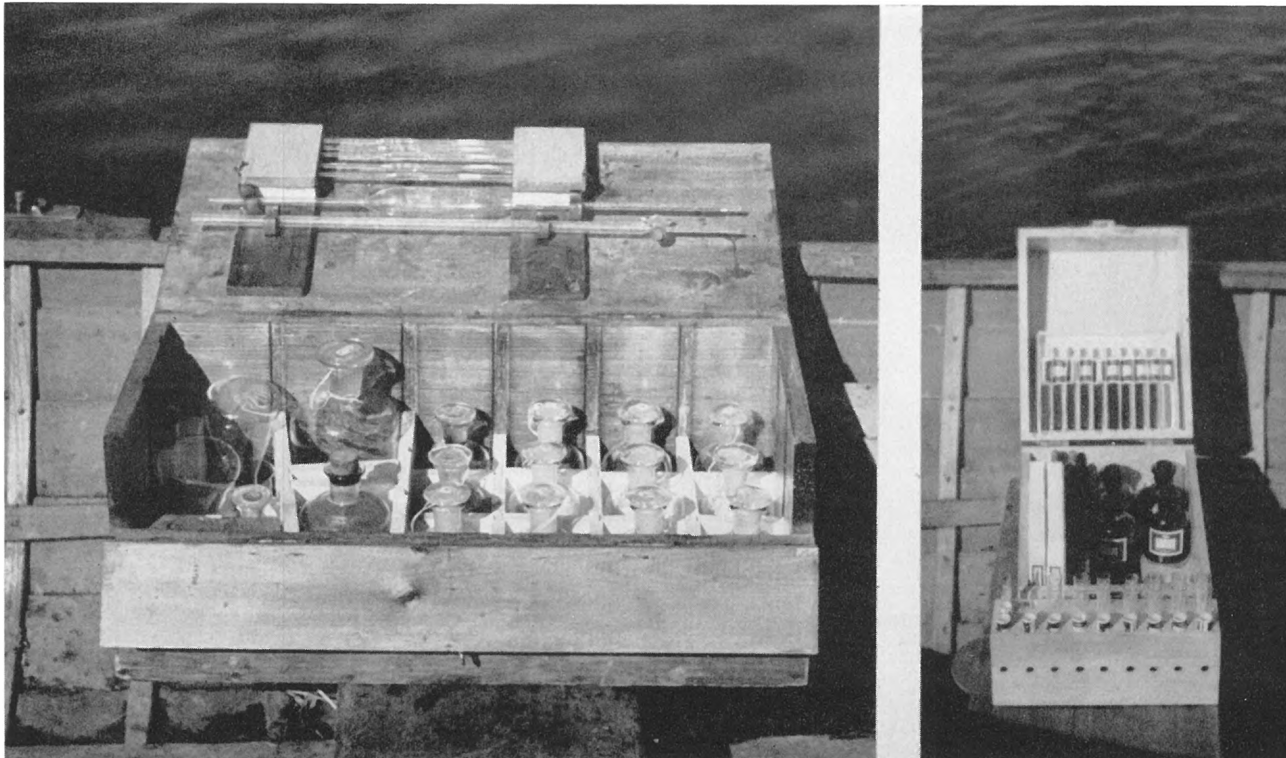


PLATE III

Water analysis kits for oxygen (left) and pH (right).

PLATE IV

Collecting plankton from lake water with a Birge Closing Net. Left: Net open as it is lowered to desired level. Right: Net closed and hauled to surface.

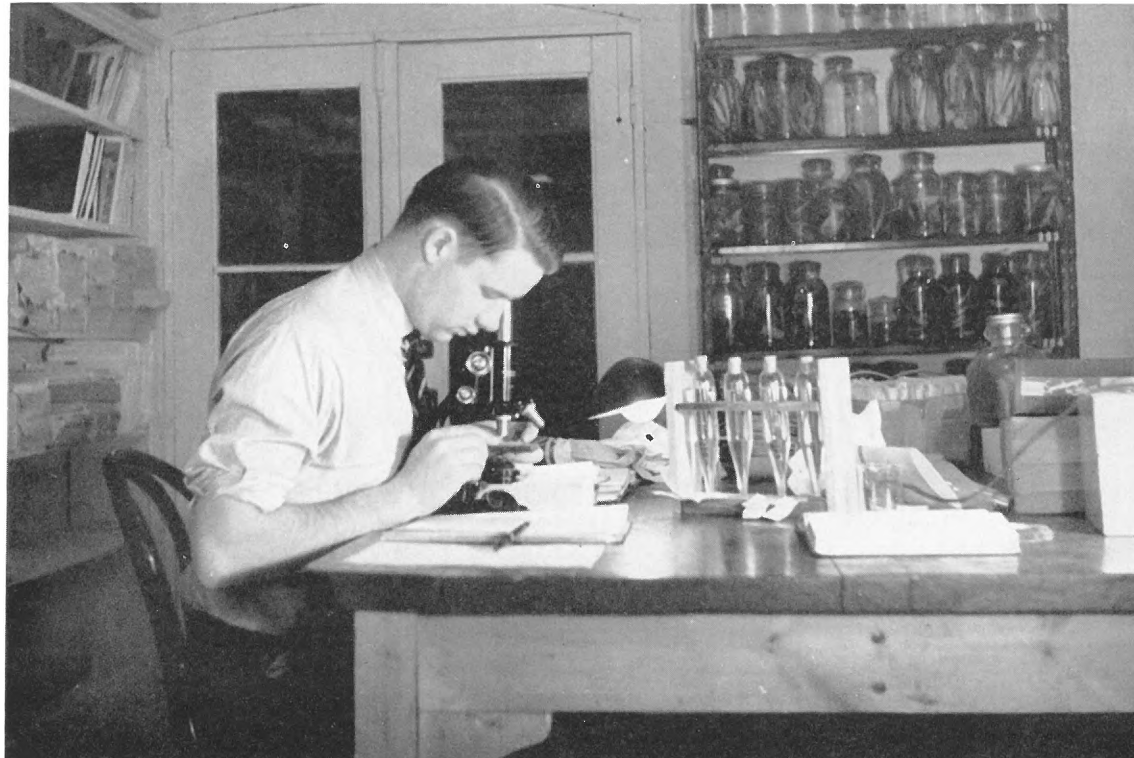


PLATE V

Analyzing plankton samples in the laboratory.

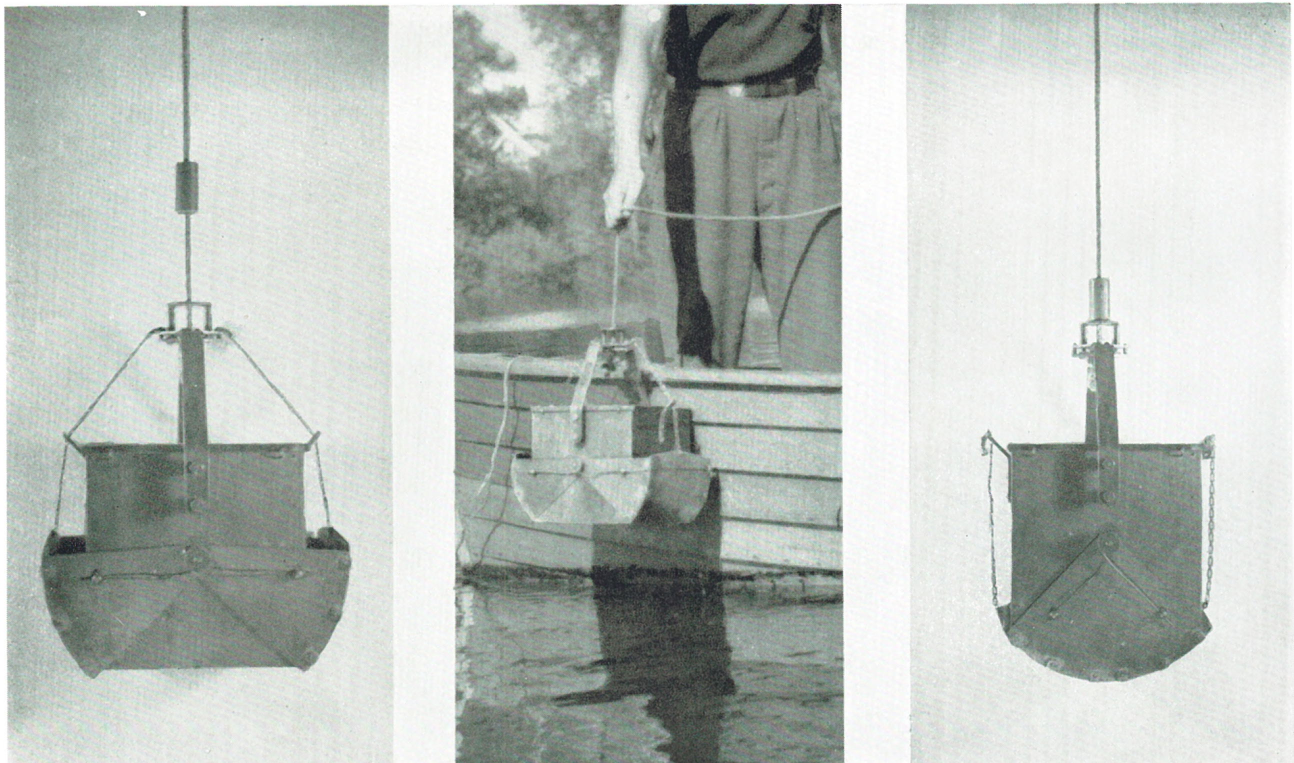


PLATE VI

Ekman Dredge used for collecting samples of lake bottom.

Left: Sampler open. Center: Sampler open and being lowered in lake. Right: Sampler closed.

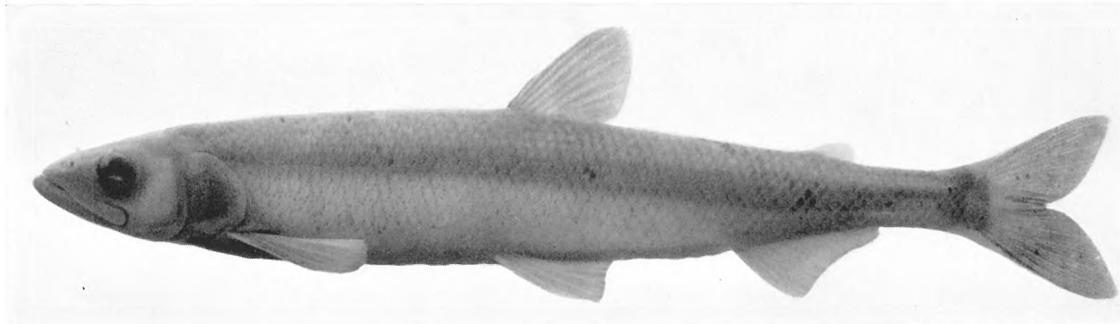


PLATE VII

Smelt *(Osmerus mordax)*

Ripe female, 1.1 ozs., 6.7 inches long. From Dennys River at Dennysville, Maine, on April 25, 1938.

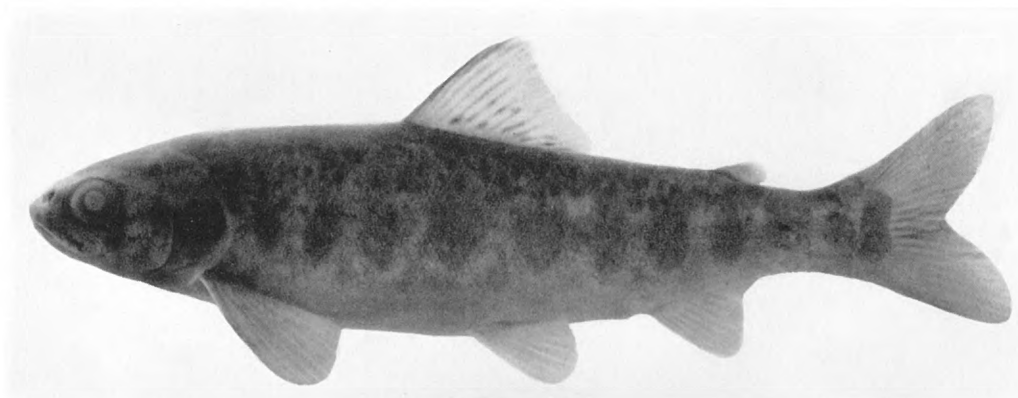


PLATE VIII

Land-locked Salmon *(Salmo sebago)*

Immature male in parr stage, 0.7 oz., 4.7 inches long. From Mutiny Brook, tributary to Bear Pond (P. 321), Waterford Township, Oxford County, Maine, on July 1, 1938.

PLATE IX

Brook Trout or "Square-tail" *(Salvelinus f. fontinalis)*

Immature female, 1.3 ozs., 6.2 inches long. From Colcord Brook, Porter Township, Oxford County, Maine, on June 29, 1938.

PLATE X

Creek Chub or Horned Dace *(Semotilus a. atromaculatus)*

Immature male, 0.7 oz., 4.8 inches long. From Sparrow Brook, tributary to Anasagunticook Lake at Canton, Maine, on August 20, 1937.

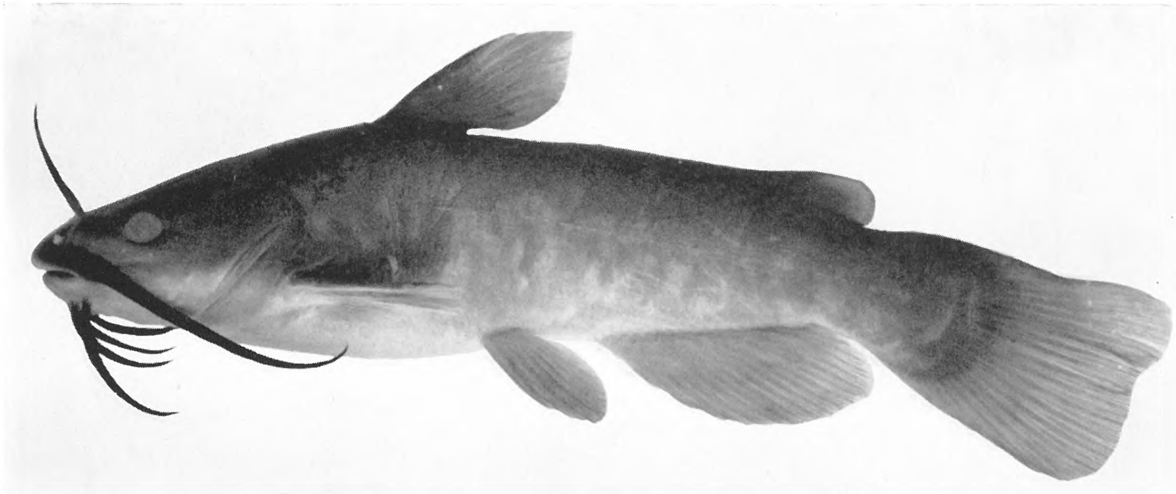


PLATE XI

Horned Pout or Common Bullhead *(Ameiurus nebulosis)*

Immature female, 1.5 ozs., 5.9 inches long. From Trickey Pond (P. 303), Naples Township, Cumberland County, Maine, on August 18, 1938.

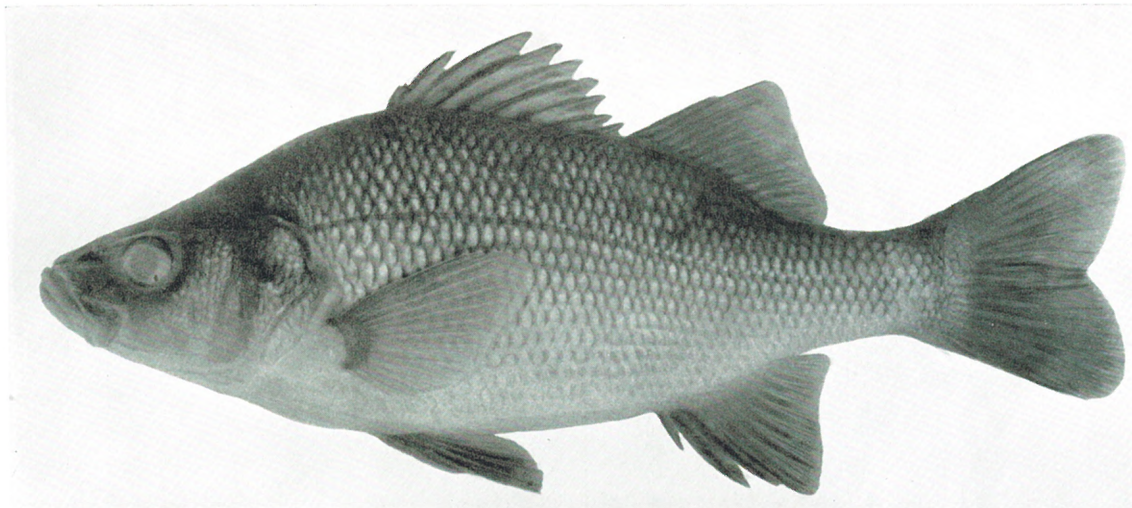


PLATE XII

White Perch *(Morone americana)*

Adult female, 9.4 ozs., 9.9 inches long, five years old. From Graham Lake, Waltham Township, Hancock County, Maine, on February 12, 1939.

PLATE XIII

Yellow Perch *(Perca flavescens)*

Adult female, 4.8 ozs., 8.5 inches long. From Crystal Lake (P. 324), Harrison Township, Cumberland County, Maine, on August 26, 1938.

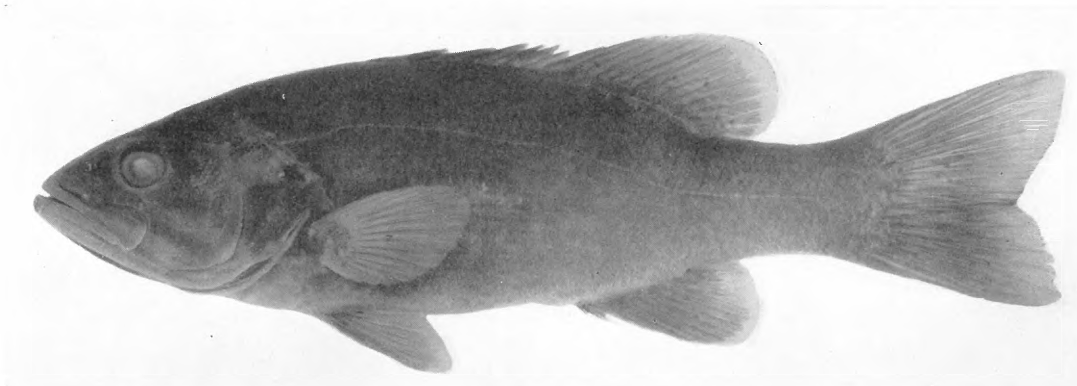


PLATE XIV

Small-mouthed Bass *(Micropterus dolomieu)*

Immature male, 6.0 ozs., 9.1 inches long. From Keoka Lake (P. 322), Waterford Township, Oxford County, Maine, on August 26, 1938.